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VOL. 9 No. 3 Published Monthly MARCH 1960

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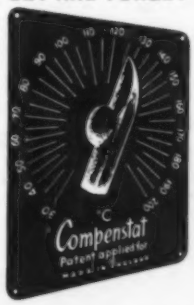

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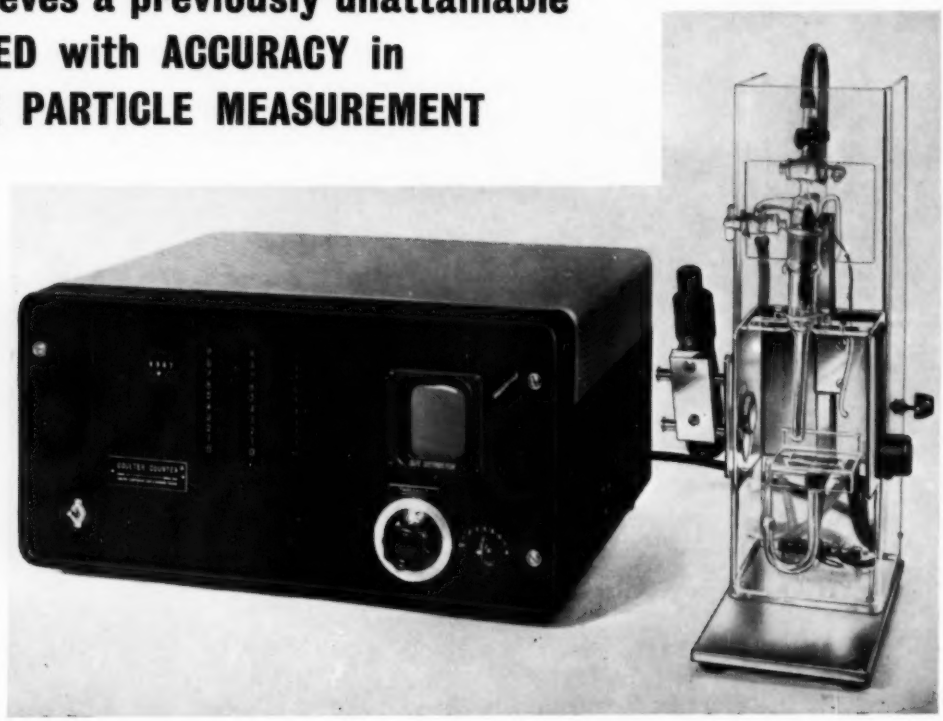

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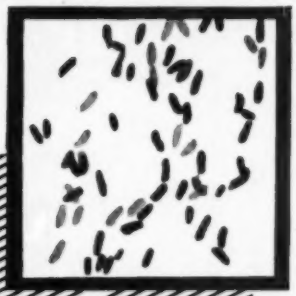

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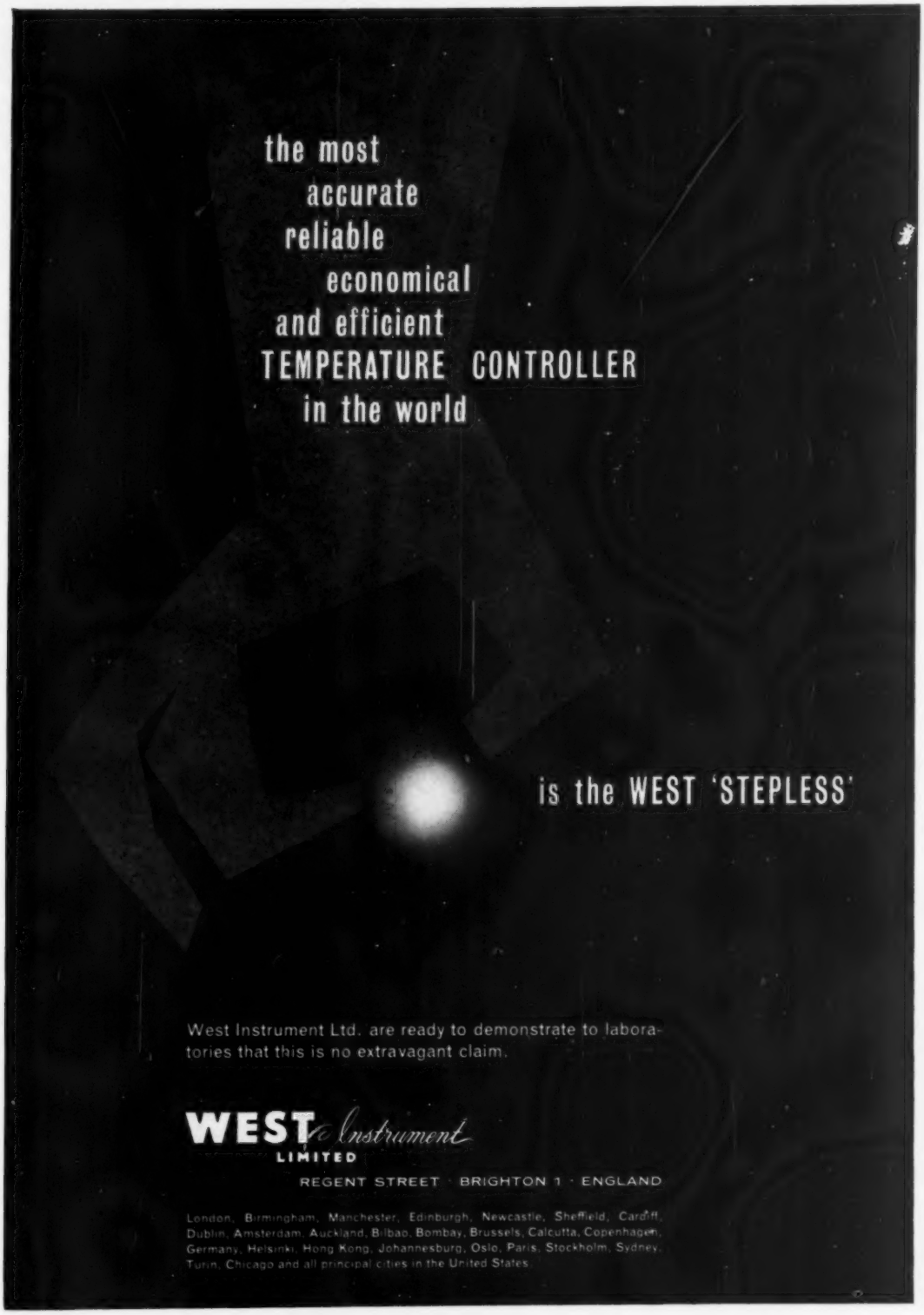
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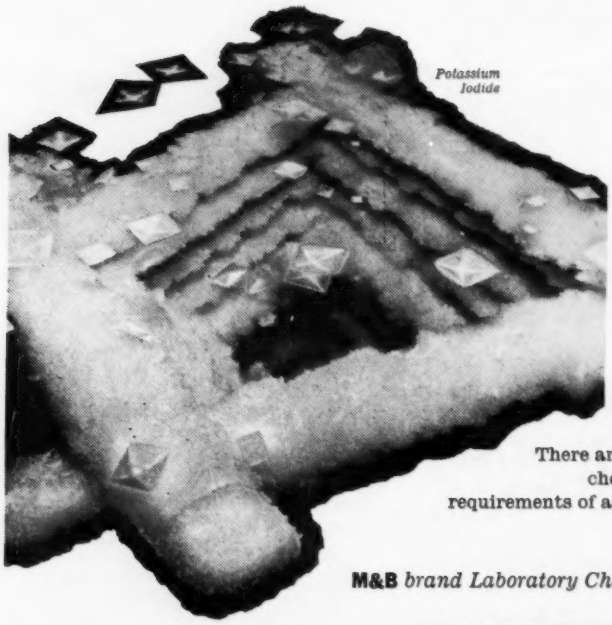

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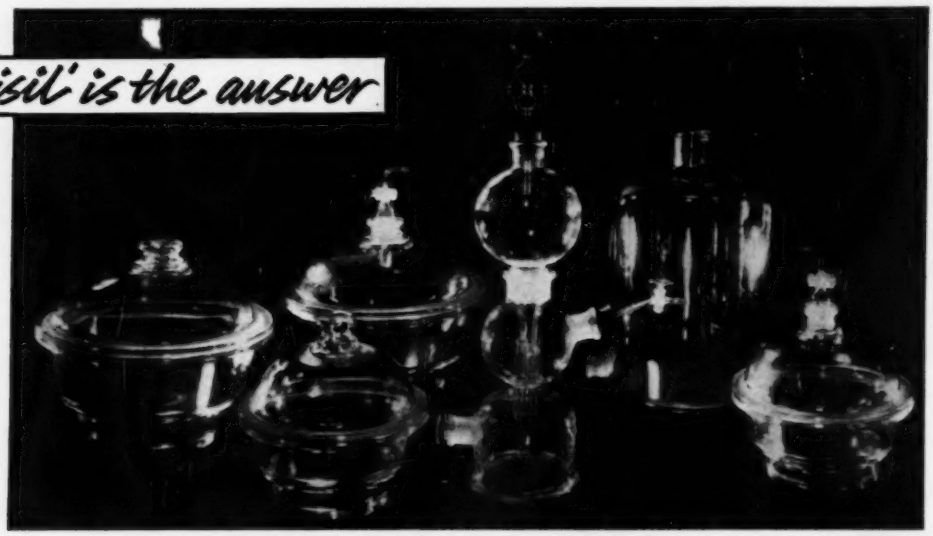

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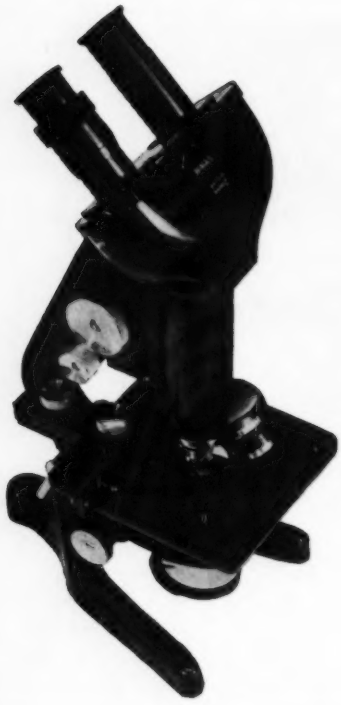

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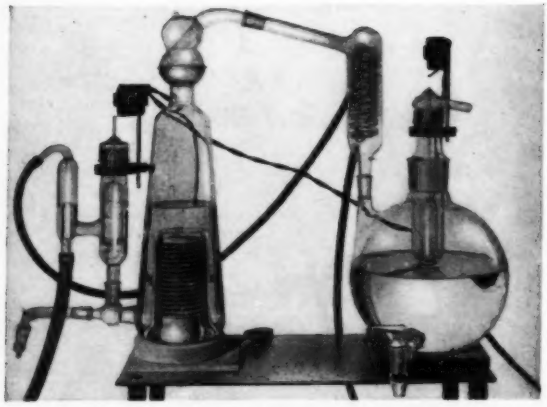

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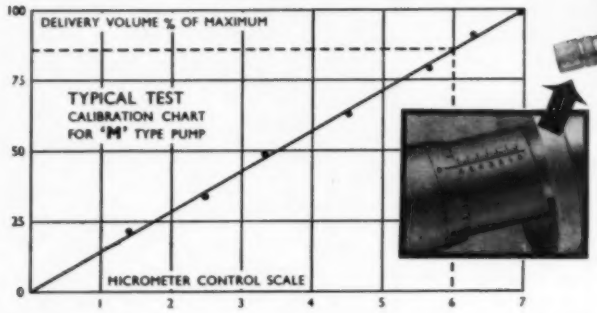

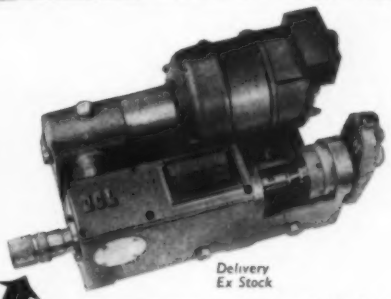

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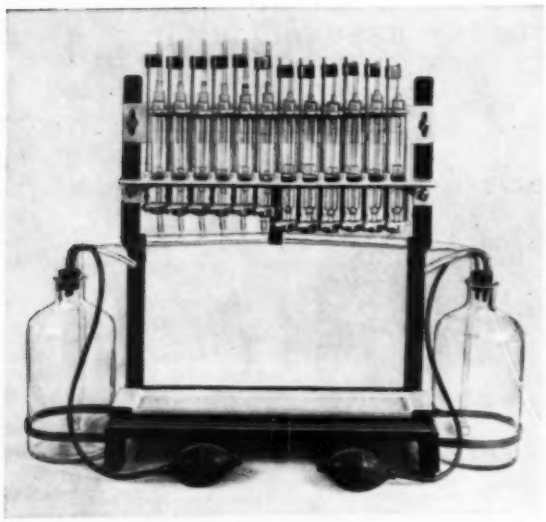

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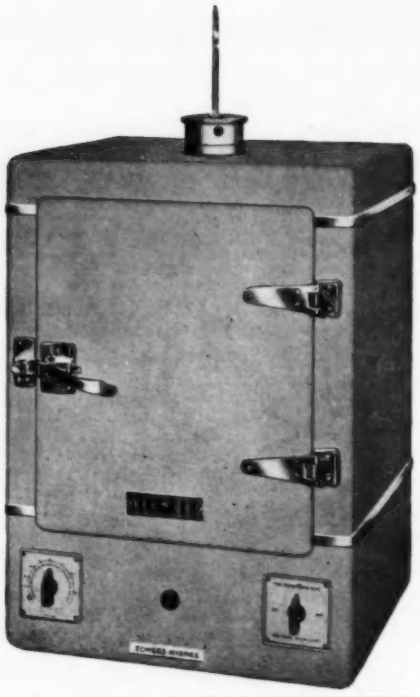

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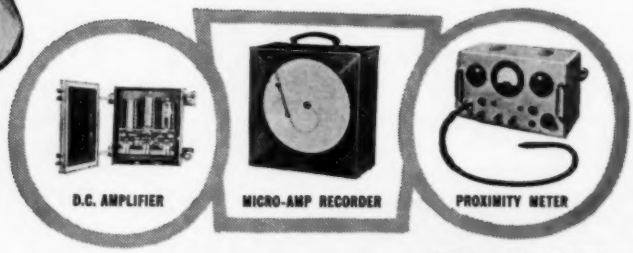

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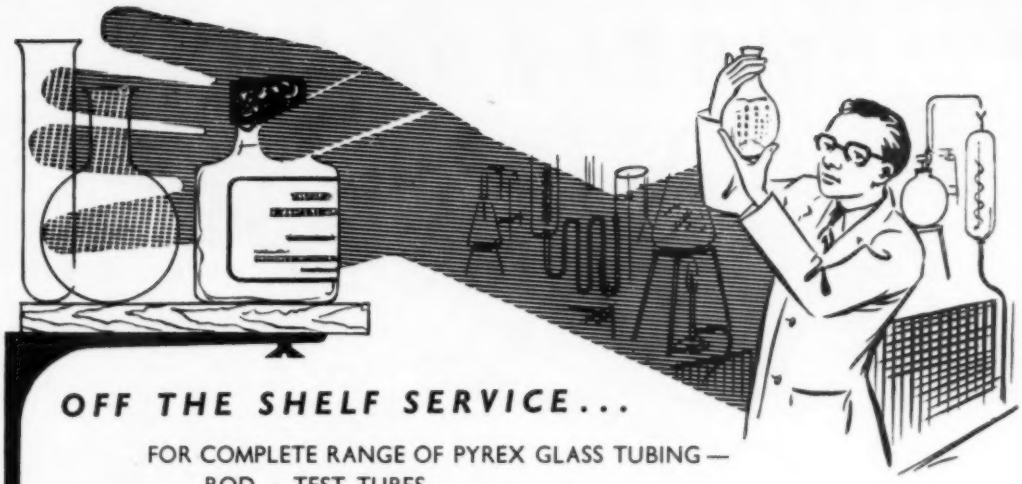

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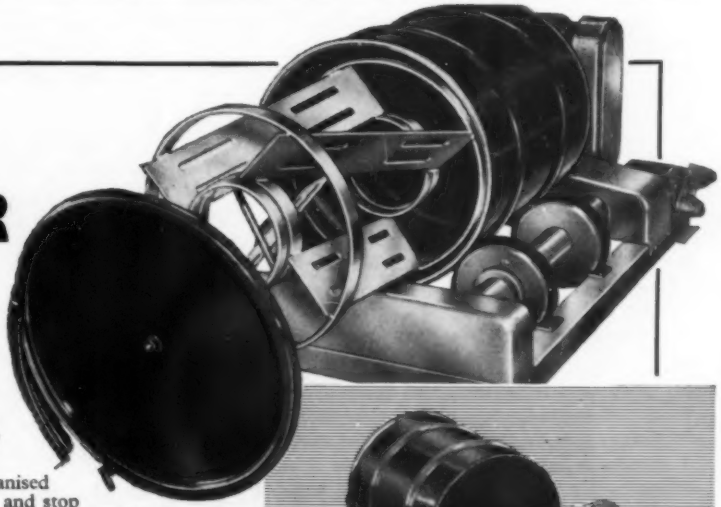

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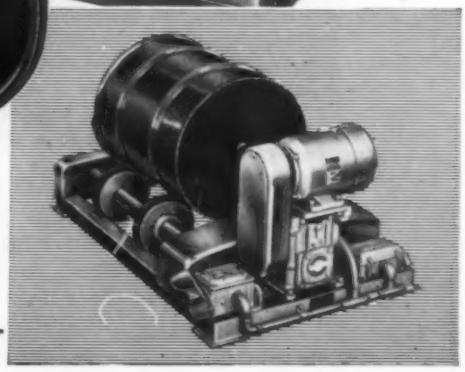

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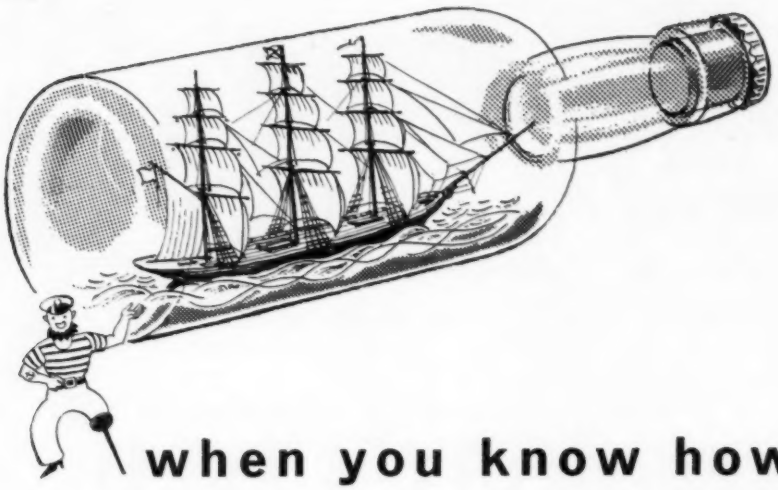

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EDITORIAL

Hints for the Chancellor

As we pass through the seasons certain topics assume prominence at fixed times with unfailing regularity. With the approach of the budget nearly every journal and paper makes at least one reference to it and many organizations make representations to the Chancellor giving reasons why tax reliefs (if any) should be given in one way rather than another. In fact, there is an interesting parallel to the way in which employees' organizations regularly send in demands for more pay, because the two things are fundamentally identical.

There is general agreement among the professional economists that the fairest and best way to absorb any surplus is to reduce the standard rate of income tax. All tax payers benefit and the extra money made available is spent evenly throughout all industries by all social classes in a variety of ways. This method will be approved by all except those who pay no income tax at all. If parallel with this reduction in direct taxation there could be a reduction in purchase tax and perhaps the abolition of purchase tax on essential goods, especially domestic items, everyone should be satisfied.

However strong the case economically for such a procedure, moral considerations should enter into financial matters, even where the State is concerned. There are three aspects which are worthy of revision both morally and on grounds of rational argument.

The first is the system whereby a man and woman are penalized because they happen to be married. In the days when it was the exception for a married woman to work for a salary, this device was obviously a method for evading tax—a man could pay his wife a salary or arrange for her to receive an income by any one of a number of ways. Today there are millions of married women working, and when there is an acute demand for skilled workers, and especially for those in science and technology, it is absurd to discourage married women, especially professional women, by vicious taxation. If the State has to tax individuals, then people should be taxed as individuals. If a woman earns a salary her married status has nothing to do with it, and she should be taxed exactly as her single sister. The more com-

petent and harder working the woman, the more severely is she taxed. A husband and wife each earning £2,000 p.a. pay a total tax of £1,320 p.a. If they get divorced or live without legal ties their tax is only £986 p.a. It is amazing that such a condition should have been allowed to exist so long.

The second point for attention is the utterly indefensible Schedule A tax, which would be ludicrous if it were not such an imposition on the most deserving members of the community, the young married couple who start building a home. The conception that a house is a source of income if one buys it (generally on a mortgage), but not if one rents it is so incongruous that it is surprising that even the case-hardened consciences of the Inland Revenue Department have swallowed it. If a house is a source of income, why then are not cars, gardens, allotments, workshops, typewriters, yachts, musical instruments and in fact almost everything that one possesses, also taxed? Further, a married man is under a statutory requirement to provide accommodation for his wife and family, so that the State taxes him if he does it and imprisons him if he does not. To talk of a property-owning democracy sounds like a poor jest when such a ridiculous tax is levied year after year. Let us hope that the Government will at last see things in their right perspective.

The third aspect which we feel should be considered is the level at which surtax begins to operate. This has been £2,000 p.a. since before 1939 when money had about three times its present value. Just as the judges have been grossly underpaid for many years, so have the more able and hard-working members of the community been over-taxed during the last few years. Most successful professional men today are in the £2,000-£3,000 range of incomes. Even at £2,000 a man with a wife and two children (the average family) will pay about £350 in direct tax. With £3,000 p.a. he will pay about £730 in income tax and surtax. But out of the £2,270 left he has to maintain an appropriate standard of living and usually educate his children, which may cost him from £600 to £1,000 a year from the ages of about eight to about 22 or even longer. It is not surprising that such a man is relatively worse off than a 'worker' getting £20 a week. We persist in a taxation system which penalizes endeavour and rewards laziness and slickness, and encourages tax-dodging by offering substantial benefits to those who are adept at it.

A family man with an income of £10,000 is considered to be well off, and there are not many who reach this level. Yet after tax he has only about £4,900 left, and his family and friends and numerous charitable organizations will expect him to behave like a wealthy man. If instead of doing his duty to the State by marrying and rearing a family he prefers the freedom and pleasures of the single state, he can adjust his taxation by the simple device of forming a company and appointing four lady friends as directors at £2,000 p.a. Such a *ménage à cinq* would then pay in tax only £2,465 as against the tax of about £5,100 paid by a man supporting a wife and three children. Could anything be more ridiculous? An adjustment of the surtax level is long overdue. Rationally it should be raised to £6,000, but there should at least be a start by raising it to £3,000 in this next budget.

Another curious anomaly is the system of taxing a retirement income as 'unearned income' which just about doubles the tax payable. For example on a retirement income of £600 p.a. the tax is £84, but if it were earned in the ordinary way it would be only £42. When we consider that all savings have to be made from a taxed income, and that this is another example of double taxation, the unjustness must be apparent to all. There are others which are not obvious to the ordinary citizen, but in days of high taxation there is no justification for double penalties. These are often inflicted on those who already have other burdens to bear.

Another aspect which is purely practical is the limit at which taxation begins. It costs nearly as much to collect £10 as it does £1,000 and the fewer the number of taxable incomes the better from all points of view. The cost of collecting taxes has nearly doubled during the last 10 years. If the personal and especially the married allowances were increased, many 'nuisance' tax accounts would disappear. The cost of the Inland Revenue Department could then be reduced or its energies redirected to more profitable fields—the large scale tax-dodgers.

The Council for Scientific and Industrial Research

The Minister for Science has appointed Prof. Charles Frederick Carter to be a member of the Council for Scientific and Industrial Research. He takes the place of Prof. E. A. G. Robinson, who retires on completion of his period of service.

Prof. Carter is Stanley Jevons Professor of Political Economy and Cobden Lecturer in the University of Manchester. He is 40 years old, the son of F. W. Carter, F.R.S. and was educated at Rugby School and St. John's College, Cambridge.

Prof. Carter's interests are in the field of applied economics. He is the author of 'Industry and Technical Progress' (with Prof. R. B. Williams), published in 1957, and 'Investment in Innovation' 1958. He is chairman of the Science and Industry Committee of the Royal Society of Arts, the British Association for the Advancement of Science and the Nuffield Foundation.

The present constitution of the Research Council is:

Chairman	Sir Harry Jephcott
Members	Sir Eric Ashby
	Prof. C. E. H. Bawn
	Prof. P. M. S. Blackett
	Prof. C. F. Carter
	Mr. H. Douglass
	Sir Walter Drummond
	Sir Willis Jackson
	Vice Admiral Sir Frank Mason
	Sir Harold Roxbee Cox
	Dr. C. J. Smithells
	Mr. L. T. Wright
Secretary	Sir Harry Melville

ORIGINAL CONTRIBUTION

A REVIEW OF THE OCCURRENCE AND TESTING OF PYROGENS AND THE PRODUCTION OF PYROGEN-FREE SOLUTIONS

by A. R. M. Bewick

Biological Department, Abbott Laboratories Ltd.

Pyrogen-free injections can be made by ensuring a good technique for distilling water and cleaning bottles. This is discussed. Evidence is provided in support of the theory that pyrogen is adsorbed by glass and is released on autoclaving. Some factors to be taken into account when conducting a pyrogen test are dealt with and special attention is paid to the rate of injection.

THE fact that injections of aqueous solutions may cause a reaction has been known since the middle of the nineteenth century. These reactions are characterized by fever, beginning 30-45 minutes after the injection, usually reaching a peak within two hours, and have been attributed to the presence, in the intravenous solution, of pyrogens. The term 'pyrogen' is limited to substances derived from viable organisms and which elevate the temperature. Chemicals are known which, on injection, will cause a rise in temperature, but the term 'pyrogen' applies only to such substances derived from bacteria. Pure cultures of yeasts and moulds have not as yet been found to be pyrogenic, and in conducting experiments, pyrogenic material is generally obtained from a Gram-negative organism, as these have been shown to be prolific pyrogen producers, due to a substance apparently associated with the endotoxin.[1]

Not a great deal is known about the nature of the pyrogenic substance in pharmaceutical solutions, but it must be present in a very active form because the few bacteria originally present are represented only by their soluble by-products, usually much diluted.

Although pyrogen reactions are not severe enough to prove fatal to a normal person, they can be extremely distressing. Dare and Mogey[2] have reported the following symptoms, in a positive response to a pyrogenic injection, in man. Aching in the lumbar region and limb joints, a feeling of cold, spasms of shivering, nausea and headache. They report that the subject lost colour and often turned ashen grey. The patient who requires large volumes of intravenous fluids is usually seriously ill, and the introduction of a pyrogenic solution may alter the prognosis and have a fatal result. Consequently, it is of great importance that the presence or absence of pyrogens is determined before any preparation for injection is released for use.

Occurrence of Pyrogens and Production of Pyrogen-free Solutions

It has been stated[3] that many municipal water supplies are pyrogenic, both before and after distillation without baffle plates and traps. In these laboratories a pyrogen test was conducted on the local water supply and it was found to be apyrogenic, but on repeating the test on another occasion it was found to be strongly pyrogenic. Any local water supply should be viewed as a potential source of pyrogen contamination.

When the manufacture of drugs for parenteral use is contemplated, the problem arises of the pyrogenicity of the drug itself. Much work is still being done on this, but it follows that the better the drug is as a medium for bacterial growth, the easier it is to obtain pyrogens from it. Numerous drugs have been reported to be contaminated with pyrogens. Allport[4] has reported the presence of pyrogens in dextrose injection and calcium gluconate injection. Collier and Paris[5] have found pyrogenic samples of physiological saline, injections of dextrose, sodium sulphate, and sodium lactate. Whittet[3] quotes Dorche[6] as stating that commercial sugars are generally apyrogenic, and Davis[7] has said that in a period of 10 years at University College Hospital about one ton of anhydrous dextrose had been used in the preparation of injections without any cases of pyrogenic reactions. Furthermore, these authors have found that pyrogenic samples of dextrose become apyrogenic after six months storage on the laboratory bench. Thus, it would appear that a good quality dextrose is likely to be free of pyrogens.

Pyrogens however are extremely stable, and their apparent disappearance from a solution which has been standing some months, or their loss of activity, is probably due to their adsorption into the glass of the container. It is possible that these are released into the solution on autoclaving.

In these laboratories, experiments have been made on these aspects of the problem. Empty litre bottles were taken from stores in the same condition that they were received from the manufacturers. Six bottles were thoroughly washed out and well rinsed with freshly distilled water, then again well rinsed with pyrogen-free saline. The six bottles were then filled with pyrogen-free saline. A further six bottles were also filled with pyrogen-

TABLE I.

Results of Pyrogen Tests conducted on Washed and Unwashed Bottles

Bottle	*Treatment*	*After 3 hr. with shaking*	*After Auto-claving*	*After 7½ months standing*	*After re-auto-claving*
1	Washed and	—	+		
2	rinsed in	—	—		
3	distilled	—	—		
4	and	—	+	—	+
5	pyrogen-free	—	+		
6	saline	—	—		
7	Unwashed	—	+		
8	and just	—	+	+	+
9	as received	—	+	—	+
10	from	—	—		
11	the	—	+		
12	manufacturer	—	—		

free saline without any preliminary washing and rinsing. After standing for three hours with intervals of shaking, pyrogen tests were conducted, with negative results. Immediately after this, all bottles were autoclaved at 15 pounds pressure for 15 minutes, and on cooling to room temperature, a second pyrogen test was made. In the washed bottles group, three were pyrogenic, and in the unwashed bottles group, four were pyrogenic (*see* Table I). Three of the bottles which were shown to be pyrogenic were allowed to stand on the bench until one gave a pyrogen-free result. This took seven and a half months. On autoclaving once more at the end of this time they were again pyrogenic. This then appears to suggest that pyrogens are adsorbed into the glass and are eluted on autoclaving.

The same experiment was carried out on the cap liners and caps of these bottles but the results were all negative. This suggests that any adsorption of pyrogens takes place on the glass and not on the cap. However if glassware is treated at 250°C. in a hot air oven for an hour, any pyrogens present in the glass will be destroyed. Any contamination of glassware by pyrogens must, of course, occur after the bottles have been manufactured as the temperatures attained during manufacture are more than sufficient to destroy pyrogens.

All glassware for use in the preparation of injectable solutions should obviously be prepared under the strictest supervision. Somers[8] states that glassware is often contaminated with pyrogens and that in America, strict regulations are laid down for the preparation of glassware intended to hold pyrogen-free material.

It has been definitely established that water distilled in a well baffled still, and autoclaved within 12 hours of distillation, is pyrogen-free[3]. Consequently the production of a water suitable for injection appears to be not a serious problem. However, problems are still encountered. Water for injection so produced, although pyrogen-free on leaving the still, may become contaminated with pyrogens from another source before sealing and autoclaving can be effected. At this stage it is well to remember that mere autoclaving at 15 lb. pressure will not destroy pyrogens. The water on leaving the still must be held in some sort of vessel, and if this vessel is not also pyrogen-free, then there is a great risk of the water becoming contaminated. In the same way, if the bottles intended to hold the water are not de-pyrogenized, the water may give a pyrogenic result.

To sum up, it can be said that to obtain a bottle of water for injection which is pyrogen-free close attention must be paid to the baffle plates and traps on the still, the collecting vessel and bottles must be free from pyrogens, and the finished bottle should be autoclaved as soon as possible but not more than eight hours from the time of distillation. It has been stated that a sample may develop pyrogenicity within four hours.

If only one bottle is found to be pyrogenic, it is usually much easier, cheaper and safer to destroy it, but when large quantities of solution are involved in an expensive process it may be desirable to remove the pyrogens. This can be achieved by the use of activated charcoal, which removes pyrogen from solution by adsorption, and the subsequent removal of the charcoal by filtration. Reid and Jones[9] have shown that some ion exchange resins will completely depyrogenize solutions. A variety of agents including carbon, asbestos pads, and kieselguhr, adsorb pyrogen which is eluted from them only with the greatest difficulty by using large volumes of liquids. It has been shown that sterilizing will not destroy pyrogens which may be present, but will only prevent the further growth of bacteria and hence more pyrogens.

Factors to be taken into Consideration when Conducting a Pyrogen Test

Technique.—In these laboratories three rabbits are used in a test and are rejected if their control temperature exceeds 103·7°F. Each rabbit receives a dose of 10 ml. per kgm. of the solution under test, when it is saline, dextrose or water. When other substances, such as antibiotics, anticoagulants, etc. are being examined, the dose is usually much smaller. Temperatures are taken hourly for three hours after injection, and the maximum temperature rise of each rabbit is determined. The solution is pyrogenic if the maximum temperature rise of each rabbit exceeds 1·08°F. or if the sum of the three maximum temperature rises exceeds 3·78°F. The test is deemed doubtful if the maximum rises of one or two rabbits exceeds 1·08°F. or if the sum of the three rises exceeds 2·52°F. If the test is doubtful, a repeat test is conducted using five rabbits. The solution is then pyrogenic if the maximum temperature rises of four or more of eight rabbits (comprising three from the doubtful test and five from the repeat test) exceeds 1·08°F. or if the sum of the eight maximum rises exceeds 6.66°F. The rabbits used in a test should not have a difference in the control temperature greater than 1·3°F.

Temperature.—In taking the temperature of a rabbit per rectum, for the pyrogen test, the British Pharmacopoeia states that the thermometer should be inserted

not less than 6 cm. and not more than 9 cm. The United States Pharmacopoeia states not less than 7·5 cm. Langston[10] uses a depth of insertion of 2·5 cm. In this laboratory, the depth of insertion used is 7 to 7·5 cm., but whatever depth is used it must remain constant for each rabbit throughout the test. It is well to assign one thermometer to one rabbit for use in the test, so that a rabbit will have its temperature taken by the same thermometer during the three hours of observation, thereby obviating any risk of difference in the thermometers. The method of measuring temperatures by means of thermocouple is much preferred as the thermocouple remains in the rabbit for the duration of the test and consequently does away with the extra handling and excitement involved when using clinical thermometers.

Handling of Rabbits.—Excitement, mishandling, excessive noise, too high a temperature in the rabbit house are all factors which can raise the rabbit's temperature slightly, giving unreliable results. The rabbits used in our work are kept at a fairly constant temperature, between 60°F. and 70°F., in the injection room, free from noise and unnecessary disturbance for at least two hours before the test.

Proper handling of the rabbit will reduce the risk of a small temperature rise not due to pyrogens. The animal should be grasped firmly but gently, by the skin between the shoulder blades, its hindquarters supported on the other hand, then without delay placed in the restraining box. No food should be given to the rabbit from one hour before the test, until the last temperature has been taken, although access to water may be allowed.[11]

Some laboratories appear to use a type of rabbit which allows the operator to take it on his knee while making the injection or taking the temperature. We use a pure strain of white Himalayan rabbit and, although this animal is not content to sit on a lap without holding it very firmly, this disadvantage is outweighed by the animals' great sensitivity to pyrogens. Through the years we have had no occasion to change our stock of rabbits and the restraining boxes appear to have no influence on the test. Usually the rabbits are restrained only when being injected or temperatures are taken and not during the whole period of the test.

Conditioning of Rabbits.—If a rabbit has not taken part in a pyrogen test within the previous three weeks then a 'sham' test is conducted. The rabbits are subjected to a pyrogen test in which only the injection is omitted. This keeps the rabbit more or less used to the handling incurred and the restraining boxes. If a rabbit has taken part in a positive pyrogen test, then it is given a rest period of not less than two weeks before being used again, and if the animal was concerned in a negative test, a rest period of two days is allowed. When following these time periods we find that rabbits' temperatures are not influenced by any previous injection, nor have we experienced any rabbit becoming insensitive to pyrogens.

Rates of Injection.—Some laboratories believe that excitement to the animal should be cut down to a minimum and therefore they inject at a rate of 1 ml. in one second. There appears, however, to be some variation in opinion regarding the rates of injection not only of dextrose or saline, but particularly with protein hydrolysates having a high nitrogen content. Most workers seem to agree that high nitrogen protein hydrolysates should be injected at a slower rate than other solutions. This is because the problem of providing a sufficient nitrogen intake by intravenous administration of protein hydrolysates is complicated by the reactions which occur if the concentration or rate of injection is excessive.

Goodman and Gilman[12] have stated that these reactions include nausea, vomiting and venous thrombosis and oedema of the extremity in which the injection was made. Other reactions which are relatively infrequent are hyperpyrexia, urticaria and angioneurotic oedema. These authors have also said that to avoid reactions, protein hydrolysates are usually not given in concentrations greater than 5 per cent or at a rate greater than 25 g. (500 ml. of a 5 per cent solution) per hour, i.e. 1 ml. in 7½ sec.

These reactions and rates of injection however are applicable to the human and not to the rabbit. Also the symptoms do not always include pyrexia. Consequently,

TABLE II

Weight kg.	*Amount injected*	*Rate of injection*	*Temperatures °F.*				*Max. rise*
			Control	*After 1 hr.*	*After 2 hr.*	*After 3 hr.*	
2·0	20 ml.	1 ml./1 sec.	102·3	102·8	102·7	102·1	0·5°F.
2·0	20 ml.	1 ml./3 sec.	102·9	102·5	102·8	102·6	—
2·2	22 ml.	1 ml./5 sec.	102·2	102·1	102·2	102·7	0·5°F.
2·6	26 ml.	1 ml./10 sec.	102·8	102·8	103·2	103·4	0·6°F.
3·0	30 ml.	1 ml./12 sec.	103·1	103·4	103·4	103·5	0·4°F.
2·3	23 ml.	1 ml./15 sec.	102·7	102·5	103·0	103·2	0·5°F.
	CONTROL:	NO INJECTION	102·8	103·1	102·9	102·9	0·3°F.

Comparison of rates of injection using a pyrogen-free protein hydrolysate.
(Total nitrogen = 6·6 mg./ml. Alpha-amino nitrogen = 4·1 mg./ml.).

in an attempt to clarify the situation slightly, a series of pyrogen tests was carried out in these laboratories, using different rates of injection, to determine whether or not the rate affects the test (Table II). No reactions in the rabbits were noted during or after any of these rates of injection.

This series is to be repeated but the indication appears to be that the rate of injection in the rabbit probably makes very little difference to any temperature rise. As it is desirable to make the injection as quickly as possible to avoid excitement, the quicker rates may be preferred.

Syringes and Glassware.—The treatment of these is most important as the introduction of pyrogens during the test through the use of insufficiently de-pyrogenized syringes, needles or glassware must obviously be avoided. Smith [13] considers it essential to use a separate syringe and needle for each animal, and to submit these and any flasks used to oven treatment to render them pyrogen-free. His de-pyrogenizing treatment consists of heating to 200°C. for two hours plus, which he claims has always been adequate. Welch *et al.*[14] have suggested that heating to 250°C. for 40 minutes is a suitable treatment. There is no reason to suspect our own method of heating to 250°C. for one hour to destroy pyrogens.

Rather than de-pyrogenize needles and syringes as they are needed, we find it more expedient to have all our syringes on hand and already de-pyrogenized. This is done by enclosing the syringe in an aluminium tube with screw cap,[15] and de-pyrogenizing the syringe in the container. These tubes are available in sizes which will conveniently take 20 ml., 10 ml., 5 ml., and 2 ml. syringes. The syringes have been left in their containers for as long as three months without any deterioration of their de-pyrogenized condition. The needles are de-pyrogenized in small aluminium needle boxes, and these also show no deterioration after three months. In a busy department this method of storing pyrogen-free syringes and needles can save time. The syringes are silicone-treated prior to de-pyrogenizing to prevent sticking of the barrel. This is done by rinsing the syringes with a mixture of 1 in 15 silicone fluid MS 550[16] and petroleum ether, and has been found to be very efficacious. The mixture stands up to heating at 250°C. very well indeed, and makes the injection much easier.

It cannot be too greatly stressed that, as pyrogen is a most elusive substance, it is of great importance to ensure that any rise of temperature in a rabbit is due solely to the product under test and not to any extraneous pyrogens or circumstances.

Summary

1. Pyrogen-free injections can be made by ensuring a good technique for distilling water and cleaning all apparatus concerned.

2. Evidence is provided in support of the theory that pyrogen is adsorbed by glass and is released on autoclaving.

3. Some factors to be taken into account when conducting a pyrogen test are discussed and special attention is paid to the rate of injection.

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Appointment of Deputy Director, N.P.L.

Dr. George Macfarlane, a Deputy Chief Scientific Officer at the Royal Radar Establishment, Malvern, has been appointed Deputy Director of the National Physical Laboratory. He succeeds Dr. Edward Lee, who becomes Director of Stations and Industry Divisions at the Department's Headquarters, and took up his new duties on January 1.

Dr. Macfarlane, who is 43, graduated with First Class Honours in Electrical Engineering at Glasgow University in 1937, and went on to do two years post-graduate research at Dresden, where he gained the Dr. Ing. degree in 1939.

Dr. Macfarlane, who is also a Fellow of the Physical Society and an Associate Member of the Institution of Electrical Engineers, joined the Telecommunications Research Establishment (now incorporated in R.R.E.) in 1939.

Throughout the war years he concentrated on mathematics problems in radar and microwave physics. In 1945 he became Head of the Mathematical Group, and a year later took charge of the Theoretical Physics Division. Since 1953 he has been carrying out individual research in the Physics Department.

Rocket and Satellite Instrumentation

The Society of Instrument Technology and the British Interplanetary Society are to hold a one-day Symposium in London on September 1, 1960, during which approximately eight papers will be presented on 'Rocket and Satellite Instrumentation'.

The papers proposed are as follows:

1. Outline of the investigations planned for the British space programme.
2. A design study on a communication satellite.
3. A digital data reduction system for use in the static testing of rocket motors.
4. Transducers for rocket motor testing.
5. The measurement, transmission and recording of data in the Skylark.
6. Ultra-violet measurements from satellites.

7-8. Subjects to be decided.

The object of the Symposium is to indicate the fields of new scientific knowledge which have been opened up by experiments in the upper regions of the atmosphere and in outer space and to describe the kind of instrumentation which has either already been used or will be required for future research.

ARTICLES

METHODS AND ACCURACY OF LEUCOCYTE COUNTING PROCEDURES

by Geoffrey W. G. Sharp

Department of Pharmacy, University of Nottingham.

THE first attempt to count the formed elements of blood is credited to Vierordt (1852). He diluted a known volume of blood, took an aliquot and prepared a blood smear from it on a glass slide. To perform the count he enumerated all the erythrocytes on the slide. The method was cumbersome and three years later Cramer (1855) devised a method which is essentially the basis of modern blood counting techniques. After modification by Hayem (1875), Gower (1877), Thoma (1882) and Bürker (1911) the haemocytometer we know today came into full use.

General Methods of Blood Counts

A count is performed by diluting the blood with a suitable fluid, mixing thoroughly, and filling a counting chamber before counting the cells with the aid of a microscope. As is to be expected, methods of dilution vary considerably and there are numerous types of pipettes and counting chambers. The diluting fluids are so devised that they aid the identification and enumeration of the leucocytes. The counting chamber consists essentially of a glass slide with a central platform set lower than the main surface, so that positioning a coverslip over the platform will form a chamber of known depth. By means of a graticule of known area engraved on the platform, the volume of diluted blood in which the cells are suspended is known. For the count, diluted blood is placed in the chamber, the cells are allowed to settle out on to the graticule and are counted under the microscope. By calculation the number of cells per cu. mm. can be found.

Chamber counts can be applied to leucocytes either as a group, or singly providing that stains capable of differentiating the cells are used. The erythrocytes are generally destroyed during the dilution and mixing phase in order to 'clear' the counting field. Another method which has been widely used is the differential count on a blood film which gives the relative proportions of the individual leucocytes, coupled with a total leucocyte count by haemocytometer which will thus give absolute values by calculation. The following three methods illustrate the total leucocyte count, a specific leucocyte count and the blood film differential count using standard equipment.

(*a*) *Total leucocyte count*.—The blood is diluted 1 in 10 or 20 with a weak solution of gentian violet in 1 per cent acetic acid. The mixture is shaken vigorously for two and a half minutes and two large (e.g. Fuchs-Rosenthal) chambers filled by capillation. The slides are placed in a 'humidity box' for a few minutes to allow settling of the cells without any drying out effects, and the counts performed. At least 400 cells should be counted in order to maintain a significant degree of accuracy, as the count depends upon random settling out in the counting chamber. Other precautions taken to maintain accuracy are as follows:

If 'capillary' blood is used, a deep stab with a sterilized needle is required to produce free flowing blood. Unnecessary squeezing of the finger to obtain blood can result in contamination with lymph and consequently unreliable results. The first drop is discarded to avoid high monocyte (large cell) counts. It is not known whether monocyte counts are high in the first drop of finger capillary blood taken from a warm hand, but blood from the lobe of the ear has been found to have a high count. Presumably the closed down capillaries trap monocytes, and it is suggested that massage and friction promote the circulation in the ear lobe, resulting in standard and reliable counts.

For comparative work, the apparatus should be kept in 'set' form. That is to say that a set will consist of a pipette, chamber, and coverslip preferably identified by a colour or number code. The coverslip should be marked so that each time a count is carried out it is placed in exactly the same position, with the same lower surface and each corner in the same position on the chamber. When a subject has counts performed on his blood (say) each day for a week, the same haemocytometer and technique should be used each time. In this way any technical error involved, due to possible slight variations in the apparatus are maintained constant throughout, and as the results are comparative the fixed errors are of no consequence. The flat thick coverslip should be so placed that the ruled area is in the centre of the rectangle to be filled with the diluted blood. This is important because movement of the cells during filling by capillation is known to cause errors which are only insignificant when this arrangement is used (Hynes, 1948).

(*b*) *Eosinophil counts*.—These may be carried out in a manner similar to the total leucocyte counts except that the stain used is one that clearly distinguishes the eosinophils. Sometimes the diluting fluid is one that will cause lysis of all cells except eosinophils. Manners' stain (1951) is an example of the latter, and after dilution and mixing of the blood with the stain, the chambers are filled and left for 20 minutes in order that complete lysis of leucocytes and settling of stained eosinophils shall occur. The eosinophils stand out

clearly in the field, are stained pink by the phloxine in the fluid and are easily counted. Other diluting fluids for eosinophil counts are usually of the Dunger eosin-acetone type (1910) or the Randolph phloxine propylene glycol type (1944, 1949). The acetone fluids cause breakdown of eosinophils if shaken too vigorously or too long (Henneman *et al.*, 1949) and in addition the rapid evaporation compels an equally rapid count. Propylene glycol on the other hand makes mixing difficult, prolongs the settling process and indeed in deep chambers the cells may remain at different levels making counting difficult to achieve. Lysis of other leucocytes does not occur and as eosinophils comprise only some 2 per cent of the whole the count is slow due to identification difficulties. Manners' stain causes lysis of all leucocytes except eosinophils within 20 minutes, while the eosinophils are stable and brightly stained for several hours. There is a high urea content which improves the refractive index while only raising the viscosity slightly. Rapid settling is thus possible.

(*c*) *Blood film preparation and differential counts.*—Blood films are prepared by spreading a small drop of blood uniformly over a smooth glass surface which is usually a slide or coverslip. The methods used vary from the traditional two slide technique where one slide held at an angle of about 45° spreads the blood when it is pushed over the surface of the second slide, to blood film 'machines' which aim at a uniform distribution of all the cells present in the drop of blood. The coverslip method gives an even distribution and has been described in detail by Wintrobe (1946). The glass slips must be clean and grease-free before a small drop is placed on one of them. A second slip is then placed over the drop sandwiching it between the two. After the blood has spread between the two surfaces, the slips are pulled apart with a sliding movement keeping the surfaces horizontal throughout. The film is preferably dried rapidly before treatment with a suitable differentiating stain. Stains of the Leishman type are commonly used and properly handled give excellent results. Ideally all the leucocytes present in the drop of blood should be identified and the numbers of each type recorded during microscopic examination of the film. In practice this is impossible to achieve so that generally a large number of leucocytes (e.g. 500) are counted and assumed to be representative of the whole. As this depends upon a uniform distribution of cells the preparation of 'good films' is essential. In fact however small leucocytes such as the lymphocytes tend to be present in greater proportion in the middle and body of the film, while the large neutrophils and monocytes tend to be pushed along to the sides and tail in greater numbers. The better the film, however, the nearer is the approach to a random distribution, and fairly simple counting techniques will produce reliable results. There seems to be little point in carrying out complex counting techniques of the 'battlement' type when the trouble is due to faulty film making. The problem is discussed further in the next section along with considerations of accuracy.

The Accuracy of Blood Counts

(*a*) *Chamber counts.*—Studies on the accuracy of blood counts started in 1878, when Abbe pointed out that the accuracy was expressed by the equation

$$\sigma = \sqrt{m}$$

where σ = mean error

and m = the number of cells counted.

This theoretical study was confirmed three years later by Lyon and Thoma (1881) who in three experiments showed that the mean error corresponded closely with the theoretically expected error.

In 1905 Kjer-Petersen working on the accuracy of white cell counts, counted some 30,000 cells with an average of 333 cells/count. The mean error of all his counts was 5·2 per cent of the average. This value lies very close to the theoretical value based on the Abbe formula.

$$\text{viz. } \sigma = \sqrt{m}$$
$$= \sqrt{333}$$
$$= 5{\cdot}48 \text{ per cent.}$$

Bryan, Chastain and Garrey (1935) pointed out that there were five main sources of error in this type of count viz.:

1. Errors of filling the pipettes.
2. Errors of dilution.
3. Errors of calibration in pipettes and haemocytometer chambers.
4. Personal operator bias.
5. Sub-sampling including:
   (*a*) mixing of the cells and diluting fluid;
   (*b*) filling the chamber by capillarity;
   (*c*) settling of the cells by chance on the ruled counting chamber.

Scrupulous care will obviously eliminate the first two sources, while calibration errors are of no significance when comparative results are required (e.g. changes in leucocyte counts) and the apparatus remains unchanged for successive counts. Operator errors can be removed by scrupulous care and blind techniques, so that only the fifth source of error is really important. In view of the last mentioned authors, this source is by far the largest and most important.

(*i*) *Mixing of the cells and diluting fluid.*—Bryan and Garrey (1934) have shown that shaking mixing pipettes in one plane only will not give uniform mixing and large leucocyte variations can occur. Rotary mixers, or the hand shaking method of Cabot (1932) will give uniform results.

(*ii*) *Filling the chamber by capillarity.*—Hynes (1948) found statistically significant errors in leucocyte counts according to the position of the squares counted on the chamber. The two squares nearest to the point of filling gave nearly identical totals 3·5 per cent below the mean value for all four squares; the two further squares gave nearly identical totals 3·5 per cent above the mean. They found that the density of the cells on the ruled squares increases, the farther away they are from the point of filling. They also found that the leucocyte density reaches its mean value halfway along the

coverslip. For accurate counts therefore the ruled area must be exactly under the centre of the coverslip. The effect is explained by the drift of the leucocytes along the chamber during filling due to their greater density compared to the fluid.

(*iii*) *Settling of cells by chance on the ruled field.*—When all sources of error, including mixing and chamber filling, are adequately controlled, the error of blood counting resolves itself into the error of random sampling due to the chance distribution of cells on the ruled field.

Student (1907) showed theoretically that the distribution of cells in diluting fluid would follow the Poisson Law, and that the distribution of cells after settling out would follow the same law. In other words $\sigma = \sqrt{m}$, which conclusion had been reached earlier by Abbe.

Assuming that $\sigma = \sqrt{m}$

$$\text{then } \frac{\sigma}{\sqrt{m}} = 1$$

Berkson, Magath and Hurn (1939) in an experimental assessment of this statement studied both erythrocyte and leucocyte counts, and found that when erythrocytes were being counted, $\frac{\sigma}{\sqrt{m}}$ was consistently less than unity averaging 0·92. They concluded that:

$$\sigma = 0{\cdot}92\sqrt{m}$$

because of 'overcrowding' of the erythrocytes in the counting chamber. The results for leucocyte counts, where the field density is much lower, showed that $\frac{\sigma}{\sqrt{m}}$ was very close to unity, and therefore the distribution conformed to the Poisson distribution. Expressing the standard error relatively in the coefficient of variation as a percentage of the mean we have

$$V_f = \frac{100}{\sqrt{m}}$$

or if more than one field is counted

$$V_f = \frac{100}{\sqrt{n_L}}$$

where

V_f = coefficient of variation (field error)

n_L = total number of leucocytes counted.

Clearly the more cells that are counted the greater is the accuracy of the count. According to Berkson, Magath and Hurn, if the dilution of the blood is carried out accurately with the same pipette, the same chamber and coverslip used, and precautions taken to duplicate procedures exactly, the field error will be the only effective error. They analysed a number of other workers results and found that they conformed to the rule $\sigma = \sqrt{m}$. The authors of this paper then assessed the errors occurring under more usual conditions, i.e. using any blood pipette chosen from a satisfactory set, and any chamber of standard quality. Under these conditions two further causes of error are present: (1) the effective error of the chamber as a whole, and is caused by calibration and filling procedure variations and (2) the effective error of the pipette as a whole, and is caused by calibration, filling, mixing and manipulation procedures.

By experiment they calculated that the coefficient of variation measuring chamber error in percentage was $= 4{\cdot}6$, while for the pipette the error was $= 4{\cdot}7$

i.e. $V_C = 4{\cdot}6$

$V_P = 4{\cdot}7$

Therefore when a leucocyte count is estimated utilizing more than one pipette and more than one chamber, and the total count estimated from the mean of these, the errors of the pipette and chamber are diminished (the error of the mean is inversely proportional to the square root of the number of samples), and the error of the count measured as a percentage is given by:

$$V_T = \sqrt{\frac{100^2}{n_L} + \frac{4{\cdot}6^2}{n_C} + \frac{4{\cdot}7^2}{n_P}}$$

where V_T = coefficient of variation of the count

n_L = number of leucocytes counted,

n_C = number of chambers used,

n_P = number of pipettes used.

This formula is not applicable in the assessment of results where calibration and filling procedures are identical for each blood count, if the same pipette and manipulation methods are also used throughout. Any error present would be maintained constant and is of no significance in a comparative study on this basis. Therefore the error for total leucocyte counts, on the basis that not less than 400 cells are counted in any determination is derived from the equation

$$V = \frac{100}{\sqrt{m}} = \frac{100}{\sqrt{400}}$$

$= 5$ per cent.

(*b*) *Differential counts on coverslip blood films.*—The error in differential counts like chamber counts is made up of two components, the 'technical' error and the 'inherent' error. Assuming that the film has been prepared correctly, and is neither too thick nor too thin, the technical error is due to uneven distribution of cells on the slide. This on small well-made coverslip smears is relatively unimportant. There is a tendency for the larger leucocytes to be carried in greater numbers to the 'tail' of the smear than the smaller lymphocytes which have a relative increase in the body (Meulenbracht, 1921; Gyllensward, 1929; MacGregor *et al.*, 1940; Silberstein, 1940). Certain well-known precautions can be taken to minimize the irregularities, and a count taking in complete strips of the film parallel to the direction of spreading can be assumed to give an accurate differential count. Moreover when a comparative result is desired, one well-trained haematologist who makes all the blood films and performs the counts will presumably repeat any bias (due to procedure) in

all the films he makes and counts. The importance of making 'good' films cannot be over-emphasized.

The inherent error due to random distribution of the cells is still the most significant, and several workers who have investigated the subject have recommended that large numbers of cells should be counted for accurate results (Beacon, 1928; Medlar, 1931; Mainland *et al.*, 1936; Marks *et al.*, 1950). The chance error was calculated by Kilgore for a 100 cell count, and assuming there are 50 per cent lymphocytes, observation would give results between 35 per cent and 65 per cent (1920). Goldner and Mann have also shown that, as more cells are counted, so the chance of the result approximating more closely to the real figure increases. They have also published 'confidence curves' for differential counts of 200 and 500 leucocytes with a probability of 0·95 (1938).

It is obvious that the results for lymphocytes and neutrophils (which are present in larger numbers) will be more accurate than for eosinophils, basophils and monocytes, and for this reason a direct chamber count for leucocytes present in small numbers may be preferable to differential counts on blood films. A number of such methods have been described.

The development in recent years of electronic counting methods promises to bring about a radical improvement in the accuracy of blood counting, though economic considerations may restrict the improvement to research establishments. The accuracy depends on the fact that many thousands of cells can be counted in minutes, and providing that dilution and mixing methods are satisfactory a very high degree of accuracy can be achieved. This may in fact be far higher than that required by the diagnostician.

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Recent British Standards

Bacteriological and Agglutination Test Tubes

First published in 1935, this British Standard has now been revised—chiefly because manufacturers found that some of the tolerances in the first edition were unnecessarily restrictive. (B.S.625:1959, price 3s.).

Certain relaxations have been made to the tolerances in this edition, and five sizes of tube have been added.

An important feature of the eight-page Standard is the inclusion of requirements for a test for free alkali. This provides for tubes which comply with all the other requirements of the standard to be divided into two grades, according to whether they pass the test or not. The special grade is suitable where alkali leached from the glass must be kept to a minimum because it might affect the results of the work; the ordinary grade is suitable for general bacteriological work. A method of reconditioning tubes after storage is described.

Method for Determining the Permeability to Water Vapour of Flexible Sheet Materials used for Packaging

This new 20 pp. publication—the tenth in a series of British Standards on paper testing—specifies a method of determining the permeability to water vapour of flexible materials used for packaging (B.S.3177, price 4s. 6d.).

Background work on this method was carried out some years ago by the Printing, Packaging and Allied Trades Research Association and the Technical Section of the British Paper and Board Makers' Association. Shortly afterwards, it was summarized in B.S. 1133, 'Packaging Code'.

While this British Standard was designed primarily in relation to paper and laminates of paper with other materials, modifications in reporting procedure introduced by a Committee of experts have made the method acceptable to other industries—such as the plastics and cellulose film industries; and it will probably prove suitable for determining the permeability to water vapour of materials such as rubber sheeting.

Following a concise definition of 'water vapour permeability' are clauses dealing with: the basis of the method; apparatus and materials; test specimens; procedure; reporting results, and their reproducibility.

The first of the standard's two appendices deals with the method of creasing sheets. The second gives useful notes on the method directed to those as yet unfamiliar with it; they are supplemented by two full page plates illustrative of typical apparatus and manipulative details associated with the test.

Nitrogen Combustion Train (Micro-Dumas)

This newly-revised standard (B.S. 1428: Part A2: 1959, price 4s. 6d.) which specifies the various components of a combustion train for the micro-determination of nitrogen, takes account of developments in technique since it was first published (1950), notably the replacement of the Hein-Kipp carbon dioxide generator by the Tucker generator. Other changes are the replacement of the glass combustion tube by one of silica, and the incorporation of an appendix outlining the method of using the apparatus. The appendix comments that: 'Although many modifications of the original Pregl method are now commonly in use, a fairly simple one, known to give good results, has been chosen as the basis of this specification . . . '.

The present standard is one of a series of parts of B.S. 1428, 'Microchemical apparatus'; its purpose is to reduce unnecessary multiplicity in the designs of components.

Copies of these Standards may be obtained from the British Standards Institution, Sales Branch, 2 Park Street, London, W.1.

THE ROLE OF PLASTICS IN THE CONSTRUCTION OF LABORATORY APPARATUS

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PART I

THE use of plastics in the laboratory has arisen from the need to provide apparatus which will withstand the corrosive and abrasive action of chemicals while affording freedom from the fragility normally associated with the more conventional materials such as glass or porcelain. Although plastics have their limitations, and so far none has been found that will solve all the problems met with in a laboratory, their intelligent use can do much to promote longer life to laboratory apparatus and to reduce occupational hazard. Much still remains to be done however in educating the laboratory technician in the proper application of plastics and, even where a plastics is suitable, to ensure that the right plastics is chosen while appreciating any limitation that might be imposed. A polythene beaker, for example, is now a familiar alternative to glass but users sometimes make the mistake of exposing the plastics beaker to a bunsen flame, the result often causing them to condemn all plastics laboratory apparatus. It is essential therefore that the plastics article be used for the application for which it is suitable and conversely for the user to choose the right application for the particular plastics. With correct choice of plastics and correct usage a prolonged life with increased safety will result.

The most commonly used plastics in the laboratory are polyvinyl chloride (P.V.C.), polythene and acrylic (Perspex). Two types of polythene are now available, low density or 'flexible' and high density or 'rigid', and except for those applications where one wishes to make particular use of the flexibility of low density polythene, such as in squeeze bottles, the latter material is to be preferred. A newcomer in the 'polythene' family of interest is polypropylene, which offers some marginal improvement in heat resistance and clarity, and possibly also in chemical resistance, though much more practical experience is necessary to confirm this. Although more expensive at the present time, polypropylene is potentially cheaper than polythene and this, coupled with the marginal improvement in some properties, would make it preferable to 'rigid' polythene. Until there is this price advantage it is the author's opinion that the improvement in physical properties is too marginal to warrant its general substitution for polythene, though the fact that it is a 'new' material will undoubtedly make some appeal, and in the case of such items as measuring cylinders, even a marginal improvement in transparency is worth while.

Other plastics such as polytetrafluoroethylene (P.T.F.E.), polystyrene, phenolformaldehyde (P.F.), etc., are also used but on a more limited scale. With the exception of P.T.F.E. and P.F. all the plastics listed are very limited as to the temperature at which they can be used and in general they should not be used over about 60°C. though this will to some extent depend upon the type of application and the stresses involved. Thus certain P.V.C. tubing can be autoclaved at 125°C. without damage but it could never be used for transporting a fluid at this temperature. On the other hand P.T.F.E. can be successfully used up to 250°C., the limitations of this material lying in its high initial cost and the difficulty of working. These plastics differ considerably in their resistance to chemicals, such information being readily obtained either from the plastic manufacturers or quite often from the apparatus stockist. As a rough guide, P.T.F.E. is the most chemically resistant plastics, polythene and polypropylene are resistant to acid and alkalis but not solvents and strong oxidizing agents; unplasticized P.V.C. has somewhat similar resistance to polythene but is more resistant to oils and will withstand the action of some solvents; and acrylics ('Perspex') are resistant to dilute acids and alkalis, but have a pronounced tendency to craze- and stress-cracking after being in contact with solvents such as chloroform and acetone. Acrylics have the outstanding advantage of being optically clear.

Constructional Use of Plastics in the Laboratory

An early constructional use of plastics in the laboratory was in the manufacture of fume cupboards and ducting, an application where metal or wooden cupboards are still largely used, but which soon become shabby due to the effect of chemicals and fumes. Unplasticized P.V.C. is the most commonly used plastics, mainly because of its rigidity, so that advantage can be taken of its constructional properties. It is also outstanding in its resistance to acids and alkalis, though it is softened and swollen by certain organic solvents. For carrying out reactions involving powerful oxidizing agents such as perchloric acid, unplasticized P.V.C. is almost a 'must' due to the potential fire risk if wood is used. Care must be taken in the siting of heaters, hot plates, etc., and there must be an adequate draught because unplasticized P.V.C. rapidly loses its strength and rigidity above 60°C. With these limitations kept in mind it is possible to design a plastics fume cupboard which will be well-nigh trouble-free, because as well as offering the

Left: **Fig. 1.** *Above:* **Fig. 3.**

Fig. 2.

Fig. 4.

maximum chemical resistance and freedom from corrosion, its highly polished self-coloured surface enables utmost cleanliness to be maintained with the minimum of effort. This aspect of cleanliness is of especial importance in the handling of radioactive materials and in the food processing industry. To provide illumination of the cupboard, windows are usually constructed from Perspex, or if some sacrifice in optical clarity can be tolerated, in clear rigid P.V.C. The general chemical resistance of Perspex is not as good as that of P.V.C. and its resistance to concentrated acids and alkalis is markedly less, but it is usually adequate for the purpose. A further refinement is the incorporation of a metal mesh in the plastic sheet to render it completely shatter-proof.

Pipework and tubing is now freely available in P.V.C. and polythene with a variety of valves and moulded fittings. In the laboratory this is finding increasing application for general purpose tubing as an alternative to rubber and also for sink traps and waste pipes, where the freedom from chemical corrosion is such a useful feature, including a point often forgotten, its resistance to mercury which often finds its way down laboratory sinks.

Although perhaps not of direct interest to the laboratory it should be mentioned that P.V.C. and polythene are now being extensively used in the construction of chemical plant such as scrubbers, filters, tanks, pickling plant, pumps, etc. A number of such items are well illustrated in a recent article by Zade (1958) and several authoritative articles on the use of plastics in the construction of chemical plant have appeared. A particularly detailed account, including a comprehensive chemical resistance table on the use of unplasticized P.V.C. has been given by Mottram and Lever (1957).

Plastics in the laboratory are becoming more and more familiar as an alternative to glassware for such items as beakers and measuring cylinders where freedom from breakage is a very telling factor. However, this advantage is not without some disadvantages. In the main this is the lack of transparency of polythene articles and the different wetting properties of plastics compared to glass and porcelain, so that the quantitative transfer of solutions from plastic containers is rather more difficult. A further point to which Theobald (1959) has recently drawn attention is that the permeability to gases, and the surface adsorption and staining of plastics vessels may also give cause for concern where they are being used in accurate quantitative work.

Care should also be exercised in the cleaning of plastics laboratory ware and on no account should an abrasive be used. In general warm soapy water or detergent is all that is necessary. Stubborn stains or precipitates may be treated with bichromate cleaning solution or dilute nitric acid. Alcohols are sometimes effective in dissolving certain materials which do not respond to aqueous washing, but prolonged contact is not advised. For eliminating persistent odours, particularly of acidic materials, a concentrated solution of sodium bicarbonate is often effective.

A number of items of apparatus where plastics have been used to advantage will now be considered in more detail. Some types of apparatus could not even have come into existence if we were still dependent on the more conventional materials.

Aspirators

Large aspirator bottles ranging in size from ½ gallon to 10 gallons fitted with a polythene stopcock are now being extensively used in place of glass aspirators mainly because of the reduction in weight of the containers and the freedom from breakage. Some disappointment has been experienced in the past due to the unsatisfactory nature of the polythene stopcock which has been prone to drip. A polythene aspirator in which these defects have been largely overcome is shown in Fig. 1. A point to be remembered is that on no account should a polythene aspirator be held by the tap, particularly if it is of the type that screws into a bush welded on the bottle, because this will result in distortion of the bush, the threads will not mate properly, and the aspirator will leak.

Aspirator Stoppers

A recently patented stopper consists of a hollow plug closed at top and tail by means of sintered polythene discs. These discs have a pore size of around 10-20 microns, effectively keeping out dust and dirt while permitting the passage of air so that the contents of the aspirator can be readily withdrawn without the need for removing the stopper. If desired, a dehydrant, CO_2 absorbant, etc., can be placed in the hollow part of the stopper to protect the contents of the aspirator. The obvious advantage of a permanent stopper of this type over the numerous arrangements so often seen in the laboratory, such as bent pieces of tubing plugged with cotton wool, rubber bungs half on and half off, etc., hardly needs emphasizing.

Beakers

An extensive range of moulded polythene beakers is now available up to 2,000 ml. in size, and up to 10 litres fabricated from heavy wall tubing. The earlier polythene beakers suffered from the disadvantage that if they were picked up in the normal way when full of a warm fluid, spillage occurred due to the movement of the beaker walls. The use of rigid (high density) polythene or polypropylene overcomes this disadvantage and also offers a useful improvement as far as heat resistance and transparency is concerned. As already discussed, the improved properties of polypropylene compared to high density polythenes are somewhat marginal, and do not warrant its use at a higher price. However, because of probable lower raw material costs, there is a distinct possibility that polypropylene will become the cheaper material, and this would certainly result in its more extended use.

Where transparency is an essential, and where one still wishes to avoid the use of glass, such as in food process laboratories, acrylic beakers are available. Although suitable for contact with inorganic solutions, dilute acids and alkalis, they are not suitable for handling concentrated acids and alkalis or for organic solvents.

Too often a plastics item is merely an exact copy of the item as it already exists in some more conventional material with no attempt made to use the plastics as a design material. This is true of beakers, but one manufacturer has recently introduced a new design to give a set of beakers which nest; these are particularly robust because of a reinforcing rim at the top and they have a particularly clean pouring spout (Fig. 2).

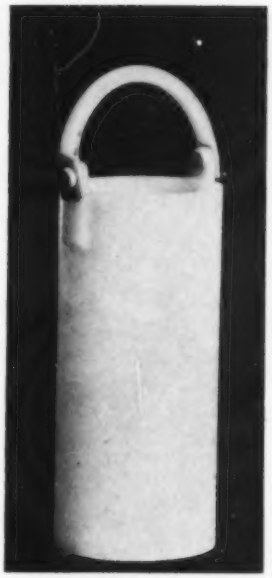


Fig. 5.

One serious limitation to the use of plastics beakers, and indeed to all plastics laboratory ware, is that they cannot be used over a bunsen flame or directly on an electric hot plate.

Beaker Covers

During evaporation a watch glass is commonly placed over the beaker or basin. Polythene beaker covers are far more satisfactory because they are unbreakable and can be obtained with moulded ribs on the underside to raise the cover slightly from the beaker top, thus materially speeding up evaporation. One company offers a range of beaker covers moulded in high-density polythene, and these are to be preferred to those moulded from conventional flexible polythene.

Bottles

A large range of moulded polythene bottles and jars is now available, some of which merit special attention. A flexible bottle with elongated nozzle functions extremely well as a dropping or dispensing bottle (Fig. 3). The use of a thin-walled polythene bottle in a protective metal container affords a cheap and superior alternative to the old-fashioned glass carboy (Fig. 4).

A standard item of laboratory apparatus is the wash bottle and this has been greatly improved by the introduction of a polythene squeeze bottle with polythene jet. Although round bottles are sometimes used, a

Fig. 6.

more satisfactory shape is a flat-sided bottle available in 250 ml. and 500 ml. capacity which fits very snugly into the palm of the hand. Round bottles are less convenient to handle.

Bottle Carriers

From a safety point of view a particularly useful article fabricated from polythene is a carrier intended for Winchester quart bottles (Fig. 5). Compared to a normal wicker basket carrier it affords far superior chemical resistance and in the event of accidental spillage or breakage will not permit the reagent to drip through on to the floor or down the leg of the operator.

Because of the high tool costs involved and the comparatively limited market, many plastics moulded items which are used in the laboratory owe their origin to the fact that they found application in the domestic market. This is true of the bottle carrier shown in Fig. 6 which was offered to the housewife for the transporting of milk bottles. In the laboratory it serves excellently for the safe transporting of four sample bottles of sizes up to 20 oz. Winchesters.

Bottle Trays

Every technician is familiar with the problem of drips down the side of reagent bottles when pouring direct from the bottle. Apart from the certainty of damaging the bench surface there is also a real safety hazard. Hitherto it has been usual to stand the bottles on glass or porcelain trays, but these are very fragile and there is also the possibility of damage to the bottle. Polythene bottle trays are now available with moulded radial ribs (Fig. 7), to raise the bottom of the bottle off the tray and so keep the bottle dry. They are made in a range of sizes from 4 in. in diameter to 13 in. in diameter. Trays with these moulded radial ribs are obviously a great improvement on the plain tray, which is also available.

Buchner Funnels

When filtering solutions on a large scale, polythene Buchner funnels are to be preferred to porcelain because of the chance of damage to the funnel if it is knocked over. Rigid polythene is to be preferred to conventional (flexible) polythene as the latter, being more temperature sensitive, is more likely to collapse as a warm solution is being filtered under vacuum. Even with rigid polythene the upper temperature limit is of the order of 50°C. dependent on the extent of vacuum applied and the diameter of the funnel used. One manufacturer has recently introduced a two-part Buchner funnel which can be taken apart to facilitate cleaning and this appears to be a particularly robust funnel.

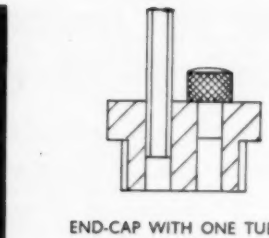
Burette Covers

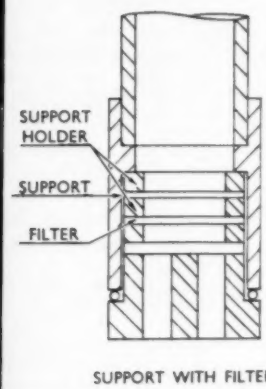
A glass test tube or some other arrangement fabricated from glass tubing is often placed over the end of burettes to keep out dirt, etc. and to prevent excessive evaporation of the contents. An improved arrangement

Fig. 7.

Fig. 8.

Fig. 9.





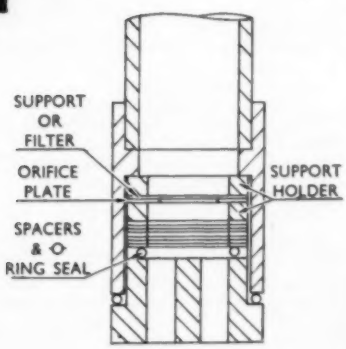


Fig. 10.

is a moulded polythene thimble preferably with internal ribs.

Burettes

Another use resulting from the squeezable nature of flexible polythene bottles is the automatic burette. The flexible bottle acts as a reservoir for the reagent, the burette being filled simply by squeezing the walls of the bottle.

A range of automatic measures employing a similar type of reservoir is also available (Fig. 8).

Chromatography Columns

Both polythene and Perspex are used for the construction of chromatographic and ion-exchange columns. One company is producing a particularly useful 1 in. bore column constructed from Perspex based on standard interchangeable parts from which it is possible to build up various lengths and to incorporate supports, filters or packings at will. The accompanying photograph (Fig. 9) shows a typical column and the line drawings (Fig. 10) some possible arrangements. Such a column should not be used above about 60°C. and. as already mentioned, certain chemicals, notably strong acids and organic solvents such as alcohol, chloroform and acetone attack it. Perspex is satisfactory for use with aqueous alcohol solutions up to about 50 per cent concentration.

Dispensers

A novel arrangement for dispensing liquids without fear of contact with the hands or the outside of the container is shown in Fig. 11. It consists of a flexible polythene bulb moulded integrally with a tapered neck that fits narrow necked reagent bottles from 250 ml. to 1,000 ml. capacity and 16 to 40 oz. Winchester bottles. Through the bulb passes a rigid P.V.C. tube for conveying the liquid. In use the bulb is pressed when the liquid is ejected from the delivery arm. This is obviously very useful for handling concentrated acids and alkalis.

Flasks

As yet plastics flasks have not made much of an impact, though there is now available a 500 ml. polythene Erlenmeyer flask with or without side tubulure so that they can also be used as filter flasks. Because of the possibility of collapse under vacuum they are moulded from rigid polythene, but even so should not be used above 40°C. when subjected to vacuum. They are particularly useful for handling hydrofluoric acid.

Fig. 11.

Filter Funnels

Possibly the largest application of moulded plastics in the laboratory is the filter funnel. Care should be taken in selecting the funnel because, as they are also of interest to the domestic market, a number of cheap poorly designed funnels are also available. For laboratory application a 60° angle funnel should be used which should be fluted or ribbed on the outside to allow the passage of air. Moulded polythene funnels are available in a range of sizes from 1 in. to 12 in. in diameter and also in a variety of wall thicknesses. While thin-walled or lightweight funnels are suitable for the simple transfer of liquids, the more rigid or heavy-walled funnel should be used for filtration, as it is essential that the filter paper should properly conform to the shape of the funnel which it cannot do if the funnel is so flexible as to be readily distorted.

Funnels constructed from Perspex are also available but as the only advantage over the polythene funnel is improved transparency, a feature rarely necessary in the case of a funnel, and there is the marked disadvantage of reduced chemical resistance, they are not of much interest except in the food processing and similar industries.

(To be continued)

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Forthcoming Congresses

The thirteenth Laboratory Animals Centre Congress will be held at The University of Nottingham on Monday and Tuesday, April 11 and 12, 1960.

The provisional programme is as follows:

Monday, April 11: In the Portland Building, University of Nottingham.
CHAIRMAN: Dr. E. R. Mitchell, Public Health Laboratory, Nottingham.
9.30 a.m. Opening of Congress by Dr. P. L. C. Carrier, C.B.E., The Home Office, London.
10.00 a.m. Laboratory Control of Infection in a Small Animal Colony, by Mr. J. Izard, Laboratory Animals Centre, Carshalton.
10.25 a.m. Coffee.
10.55 a.m. Progress Report on the Alderley Park Breeding Unit, by Mr. G. W. Ash, Imperial Chemical Industries, Ltd., Pharmaceuticals Division, Alderley Park, Macclesfield.
11.35 a.m. The Establishment and Maintenance of a Mouse Colony for the Supply of Suckling Mice, by Mr. J. C. Davis, Research Institute (Animal Virus Diseases), Pirbright.
12.30 p.m. Lunch in Cripps Hall.
From 1.45 p.m. Visits:
Party A: Boots Pure Drug Co. Factory at Beeston.
Party B: Boots Pure Drug Co. Biological Research Department.
Party C: Zoology Department of Nottingham University.
4.30 p.m. Reception by the Lord Mayor of Nottingham at the City Hall.
6.00 p.m. Dinner in Cripps Hall.
(6.45 p.m. Annual General Meeting of the Animal Technicians Association.)

Tuesday, April 12: In the Portland Building, University of Nottingham.
CHAIRMAN: Prof. E. J. W. Barrington, Department of Zoology, University of Nottingham.
9.15 a.m. The Diagnosis of Pregnancy, by Mr. C. R. Beresford, Nottingham Technical College.
9.55 a.m. The Maintenance of Invertebrates in Captivity, by Mr. G. J. Ashby, The Zoological Society of London.
10.35 a.m. Coffee.
11.05 a.m. Equipping and Staffing of a New Animal Division, by Mr. E. Quinn, Smith Kline and French Laboratories, Welwyn Garden City.
11.45 a.m. Some Problems of Animal House Design and Equipment, by Dr. S. S. Adams, Boots Pure Drug Co. Ltd., Research Department, Biology Division, Nottingham.
12.45 p.m. Lunch in Cripps Hall.
From 1.30 p.m. Visits:
Party D: Boots Factory at Beeston.
Party E: Boots Veterinary Science Division, Thurgarton.
Party F: Petfoods Limited, Melton Mowbray.
6.30 p.m. Dinner in Cripps Hall.

Conference on Solid State Microwave Amplifiers

The Institute of Physics announces that its Electronics Group in conjunction with the Radio Spectroscopy Group is arranging a Conference on 'Solid State Microwave Amplifiers' to take place at the University of Nottingham from April 6 to 8, 1960.

The subjects to be covered by the Conference include:
(*a*) Masers
(*b*) Parametric amplifiers
(*c*) Related resonance studies

Accommodation will be available in one of the University Halls of Residence.

Further particulars and application forms are available from The Secretary, The Institute of Physics, 47 Belgrave Square, London, S.W.1.

Institute of Physics

The Non-Destructive Testing Group of the Institute of Physics will hold a meeting in London on May 2-4, 1960 jointly with the Société Francaise de Métallurgie. The programme will have the general theme of the relationship between structure and physical properties of materials and will include recent advances in non-destructive testing techniques.

Corday-Morgan Medal and Prize

This Award, consisting of a silver medal and a monetary prize of 200 guineas, is made annually to the chemist of either sex and of British nationality who, in the judgment of the Council of the Chemical Society, has published during the year in question the most meritorious contribution to experimental chemistry, and who has not, at the date of publication, attained the age of 36 years.

Copies of the rules governing the Award may be obtained from the General Secretary of the Society. Applications or recommendations in respect of the Award for the year 1959 must be received not later than December 31, 1960, and applications for the Award for 1960 are due before the end of 1961.

THEORY AND PRACTICE IN THE PHYSICAL CHEMISTRY LABORATORY

by S. Lewin, M.Sc., Ph.D.

Physical Biochemistry Research School, South-West Essex College of Technology, London, E.17

PART IV—FORMULATION AND INTERPRETATION

A REPORT of a given practical work, or a chemical works report, is at times considered unsatisfactory by the respective supervisor or director. This is often due to lack of clarity of expression which in turn may be attributed to lack of understanding of the problem involved, muddled thinking, lack of capacity to express oneself or to a combination of these deficiencies. Sometimes the report may be considered unsatisfactory because it cuts across accepted conventions in that it does not differentiate clearly between the experimental details, results and their interpretation.

How is it that such reports are encountered at times, despite the years of grammar school education in both English and Science, and despite several years' preparation for higher academic and other qualifications?

The answer is probably to be found partly in the type of language teaching which spends more time on literary style than on precise meaning required in the scientific field, and partly in lack of effort on the part of the student to formulate or plan carefully what should be said in the report. The lack of effort to think is encouraged by the attitude that examination subject matter should be memorized rather than treated strictly *logically;* the result is that the student is trained to present *stored* knowledge rather than work out the problem from first principles. As is well known, but not necessarily appreciated, lack of exercise tends to result in slow atrophy of powers, be they muscular or mental. However, even though these considerations may be appreciated, it is often found that the syllabuses of several qualifications do not appear to have made sufficient allowance for them.

A course is normally planned in terms of set syllabuses of general knowledge in the theory and know-how in the practical. It is then expected that—presumably miraculously—the course of lectures and practical will impart not only this know-how but even the correct scientific attitude. The time allotted is usually barely sufficient even for the mere *transfer* of information from lecturer to student. A lecturer imbued with the importance of educating the student in scientific *principles* will readily realize that he need not teach the entire syllabus, but rather be satisfied with imbuing the students with the main principles and that he should encourage the student to use the text-books extensively so as to fill the missing gaps. After all, it is not the purpose of education merely to *transfer* knowledge, but rather to guide the student and to encourage him to develop any latent initiative. If the student were to feel that he is likely to get all the material he requires from the lecturer, he will tend to rely on the latter to an extent prejudicial to his developing his own initiative.

It should be remembered that mere storage of information and subsequent calculations are being taken over increasingly by calculating and computer machines which carry out such tasks far more quickly and accurately than can human beings.

It should also be remembered that all education and even mere training must be directed not only towards present needs, but also towards future requirements. To do otherwise, it would be not only economically and scientifically unprofitable, but also would involve a sliding back in the standard of living, because these principles, if not appreciated and utilized in one place, are certainly bound to be so elsewhere. There is an old Chinese proverb which may be translated as 'If you consider planting wheat, plan a year ahead; if you consider planting trees, plan ten years ahead; if you consider human development, plan a hundred years ahead'. This was true over two thousand years ago. It is even truer today. Future developments are bound to increase the applicability of computers to many processes which are being carried out wastefully by human beings at present. To use teaching methods which result in encouraging students to an attitude of mind contrary to scientific principles is not only erroneous intellectually, but is damaging economically.

Returning to the original question as to the cause of unsatisfactory practical work or technical reports, it should not be surprising to find that a student who has not been guided to develop his powers of formulation and interpretation finds himself handicapped when required to make original effort. Indeed, the ramifications of such insufficient development are far wider than those involved in the mere irritation produced by a technical report and its consequent re-writing, or even by the inability to appreciate examination questions with consequent failures. They may well result in unsatisfactory planning.

Planning of experimental procedure is of fundamental importance because, if inefficient, it is likely to result in considerable economic waste. To state but one factor: The carrying out of an investigation may require quite a number of control or blank experiments in order that no doubt be cast on the significance of the results eventually obtained. Now the type of control experiments required depends on the formulation of the problem. Inaccurate formulation may well result in

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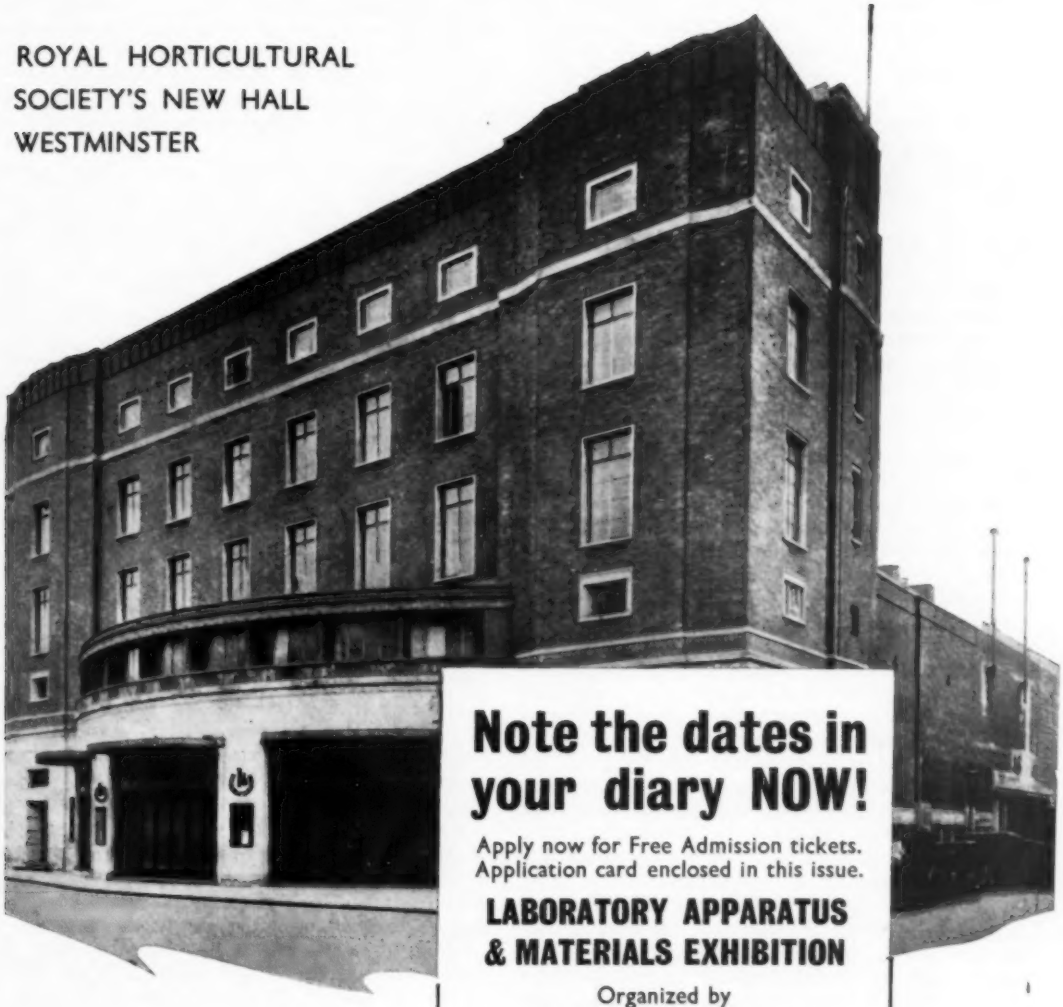

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insufficient controls and therefore in eventual negation of the significance of the entire investigation. Has it not often been found that a given statistical analysis was disputed because—so it was argued—of an insufficient number of controls? Have we not met the well known aphorism that 'there are lies, damned lies and statistics', the inference being that quite a number of series of experimental data can be interpreted in several ways, some of which are simply contrary to the truth?

With the aim of avoiding as far as possible such waste, it is desirable to consider ways and means of ensuring that the student will not only be impressed with the need to apply himself to the task of correct choice of words in formulation and interpretation, but that he will indeed do so.

The attainment of this object can be considerably enhanced by suitable alteration in the present type of examination. Some possible changes have been already advocated in this connection in Part III of the series of these papers. In internal examinations these suggestions can be readily enforced. However, changes in externally controlled syllabuses are difficult and slow to attain. In the latter, it is nevertheless possible to include certain tutorials, classes and special exercises which should enhance the attainment of the above aims. In order to be effective, these suggestions should be tackled on a scale involving both theory and practical sessions. The following are worthy of inclusion in a scheme covering the above aims:

A. *Comparison, contrast and grading.*—The student should be required to compare and contrast and, in particular, to grade a number of words so far as their suitabilities in formulating sentences required in certain connections. For example, the following words are often encountered in the description of experimental measurements or their interpretation: Determine, evaluate, measure, assess, conclude, decide, consider. The student should substitute each of these words in suitable sentences and consider the effect of the substitution on the meaning. He should also be asked to compare and contrast his own and other students' answers to variations in wording of examination questions such as:

(*a*) Define oxidation-reduction.

(*b*) Explain what is meant by oxidation-reduction.

(*c*) What is meant by an oxidation-reduction potential?

(*d*) Explain the significance of electromotive force values in oxidation-reduction processes.

B. *Comparison of two different tools which are used for the same purpose.*—Two different instruments, such as colorimeters or absorptiometers, should be made available to the student who should proceed to use them to measure a given property, e.g. the absorptive power of copper sulphate solutions of various concentrations. The student will be asked to summarize his results and to decide, giving reasons, as to whether one instrument is superior to the other.

C. *Critical assessment of laboratory or other reports.*—The student should be asked to assess critically, or otherwise, other students' experimental descriptions or reports. The cynic might be tempted to consider this as the case of the 'blind leading the blind'. However, such cynical attitude is unjustified, because the assessments will be carried out under the direction of a supervisor. To avoid confusion, the author has used a system in which the student's critical remarks were noted in red ink, while the supervisor's comments were made in green ink, the original report having been written in the usual blue ink.

The assessments need not be made in writing, they may be read out in front of the class. The important point is that the student, knowing that his work is going to be assessed by a number of other persons, in addition to his supervisor, will make an extra effort to choose his words carefully before committing them to paper.

D. *Technical report writing.*—The student should be given a title of an essay or report and be asked to submit *several* different introductory paragraphs. Their suitabilities will be compared, contrasted and generally assessed by both supervisor and other students. Clear distinction should be made between the introductory paragraph, and the bulk of the report. Emphasis should be placed on the development of a suitable concluding paragraph.

E. *Research papers.*—Clear distinction should be made between the styles required in technical report writing and those involved in scientific papers. The former is usually allowed latitude in the number of words to be used, despite the emphasis that padding should not be used. The latter has, however, to be written in a far more compact manner, because of shortage of space considerations. Because of the meagre space devoted to experimental detail, only a specialist can appreciate—and sometimes even he cannot—what has been done experimentally. Further, in most scientific papers it is required to distinguish clearly between the Introduction, Experimental, and Discussion.

Above all, it must be impressed on the student that he must check and recheck what he has written in order to make certain that not only does he himself understand the written material, but that other persons who are to read it should also be able to understand it.

Tutorials which should improve the student's powers of choice of words in formulations and interpretations may require a preliminary reading of a particularly suitable article. However, despite advice given, it may happen that a number of students will be unable or reluctant to read the article, the excuse given being that some other student borrowed the book or was reading it. One method which deserves consideration is to photostat a sufficient number of copies of the article and to have them loaned.

The above suggestions are only a few of those possible for the development of the student's powers of formulation and interpretation. They can be extended by other persons engaged in student education or training, and many ingenious innovations can be introduced.

POLARIMETRY AND REFRACTOMETRY IN THE LABORATORY

by Mary P. Lord, B.Sc., Ph.D., F.Inst.P.

Optical Consultant

PART I—POLARIMETRIC METHODS

Theory

Ordinary radiation may be considered as a collection of vibrations uniformly distributed over all directions perpendicular to the direction of propagation. When the vibrations are confined to one direction only, the radiation is said to be plane polarized. Some substances (known as optically anisotropic) have the property of rotating the plane of polarization of radiation in its passage through them. The change in direction is known as rotatory polarization or optical rotation, and polarimetry is its quantitative investigation for liquids and solutions. Substances that rotate the plane of polarization in a clockwise direction when looking against the oncoming radiation are said to be right handed or dextro-rotatory; those that rotate it in an anti-clockwise direction are said to be left handed or laevo-rotatory.

The optical rotation of a liquid or solid depends on the layer thickness, wave-length and temperature. In a solution the rotation depends, in addition, on the concentration of optically active substance and on the nature of the medium in which the substance is dissolved. Optical activity may also change with time. For the observation of a rotation to be significant, it is therefore essential to define the experimental conditions. In addition it is desirable to reduce the experimental rotations to standard values. The standard layer thickness for liquids and solutions is 10 cm.; as the rotation is proportional to the thickness, any convenient value may be used in experiments. The standard wave-length now generally used is that of the mercury green line (5461A); sometimes the earlier sodium doublet (5890, 5896A) standard is still used; the rotation is approximately proportional to the inverse square of the wave-length. The standard temperature is 20°C.; there is no general relationship between temperature and rotation.

The specific rotation $[\alpha]$ of a liquid is defined by the equation

$$[\alpha] = \alpha/bd$$

where α is the rotation produced by a layer of thickness b decimeters, of density d gm./cc. The specific rotation $[\alpha]$ of a solution is defined by the equation

$$[\alpha] = 100\alpha/bc$$

or

$$[\alpha] = 100\alpha/bpd$$

where c is the concentration (i.e. g. of optically active substance per 100 cc. of solution); p is the number of g. of optically active substance per 100 g. of solution. The other symbols are as previously. The temperature and wave-length are indicated by a superscript and subscript respectively. For example, a specific rotation valid for 5890-5896A and 20°C. is written $[\alpha]_D^{20}$. For purposes of comparison, the molecular rotatory power [M] is more convenient; this is defined for both liquids and solutions by the equation

$$[M] = M[\alpha]/100$$

where M is the molecular weight of the optically active substance. $[\alpha]$ is a true constant for a liquid but not for a solution. In general an equation of the form

$$[\alpha] = A + Bc + Cc^2$$

applies where A, B and C are constants. There is no standard medium as the choice is determined by the solubility of the optically active substance; water is most commonly used; other solvents are alcohol and benzene. For this reason, it is the practice among some workers to give the value of $[\alpha]$ extrapolated to either 0 or 100 per cent concentration.

Instruments

A polarimeter consists of a radiation source, a device (the polarizer) for producing plane polarized radiation from it, a tube for holding the liquid or solution under examination and a device (the analyser) for measuring the amount of rotation of the plane of polarization by the substance; finally, there is a detector for investigating the radiation passing the analyser. The principal features of these various parts will now be considered.

Sources

The main requirement is for an intense source of monochromatic radiation. For the visible region, the most satisfactory is the high pressure mercury vapour lamp (for example, B.T.H. 250 watt type ME compact source); this source gives out strong lines at 4047, 4358, 5461, 5770 and 5791; each may be isolated by appropriate filters. An alternative source is the sodium vapour lamp which yields the strong doublet 5890 and 5896A.

For the ultra-violet region, the mercury lamp is also useful; it has a strong line at 3650A and the low pressure variety gives a line at 2537A also. The hydrogen discharge tube is best if a continuous spectrum is required; narrow wave-length bands may be isolated with a monochromator.

For infra-red work, the Nernst filament lamp is a satisfactory source. Ribbon filament lamps are also useful.

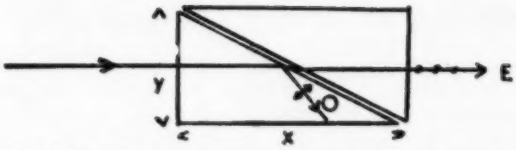


Fig. 1. The Glan prism. Direction of vibration in plane of paper denoted by arrows, perpendicular to plane of paper by dots.

Polarizers

For the visible region.—Polarizers based on double refraction are mainly used. A doubly refracting (or birefringent) substance is one which for most directions of incidence, splits a beam of ordinary light into two plane polarized beams whose vibration directions are at right angles; these beams are known as the ordinary (O) and extraordinary (E) beams. An example is calcite which for sodium light has a refractive index of 1·658 for the O beam; for the E beam the refractive index varies between 1·486 and 1·658, depending on the direction of the beam in the crystal. For the direction in the crystal for which the refractive indices are equal, the O and E beams are of course not separated and travel with the same velocity; this direction is known as the optic axis. If, as for calcite, there is only one such direction in the crystal, it is said to be uniaxial; a crystal with two such directions is known as biaxial. The vibration direction of the O beam is perpendicular to the optic axis. It is obvious that either the O or E beam can be used as a source of polarized light provided the other is suppressed.

The most popular method of eliminating one beam is by use of total internal reflection. The prism of polarizing material is divided into two parts which are later cemented together or held in position so that there is a small air film between them. The direction of incidence of the light relative to the optic axis is so chosen that one beam strikes the interface at an angle greater than the critical angle and is thus totally internally reflected (*see* Part II), while the other beam is transmitted. The reflected beam is absorbed by black paint on the side of the prism.

The principle of the Glan prism which is made of calcite and employs an air film is shown in Fig. 1. The optic axis is perpendicular to the x y plane, so that, for normal incidence, the O and E beams are not separated in direction but travel with different velocities. For $x/y = 2{\cdot}15$, total internal reflection of the O ray occurs provided that the angle of incidence is not greater than 2°. In addition to this small field, another disadvantage is that there is appreciable loss of intensity in the E beam by reflection at the interface. This is to a great extent overcome when the two halves are cemented together with a material (e.g. canada balsam) whose refractive index is nearer that of calcite than is the refractive index of air. Such a prism is known as a Glan-Thompson or Glazebrook. For a 2° angle of incidence however, x/y must be 2·81, i.e. a larger prism is required; this increases the cost considerably because appreciable cutting down of natural calcite crystals is necessary if the face on which light is incident is to contain the optic axis. An important feature of Glan and Glan-Thomson prisms is that the emergent beam is parallel to the incident beam and little displaced relative to it.

A cheaper calcite prism is the nicol which is shown in Fig. 2. For this, the end faces of the naturally occurring crystal are only slightly ground away; the dotted line in Fig. 2 indicates the position of the face before grinding; the long edge is about three times the length of the short edge. For canada balsam cement, the prism works for angles of incidence not more than 12° different from that for the ray incident parallel to the long edge of the prism. It has, therefore, a larger field than the Glan and Glazebrook prisms. However, the displacement of the emergent beam with respect to the incident beam is considerably greater. This is a disadvantage when the prism is rotated and so, in work of the highest accuracy, the prisms previously described are used. It is, however, customary to call any calcite polarizing prism a 'nicol'.

For the ultra-violet and infra-red.—The polarizers described above are satisfactory down to 3500A. For

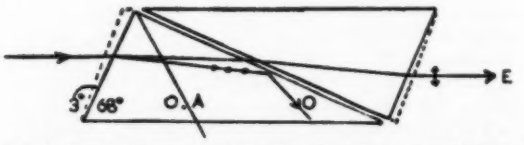


Fig. 2. The Nicol prism. Vibration directions denoted as in Fig. 1. O.A. is the optic axis direction.

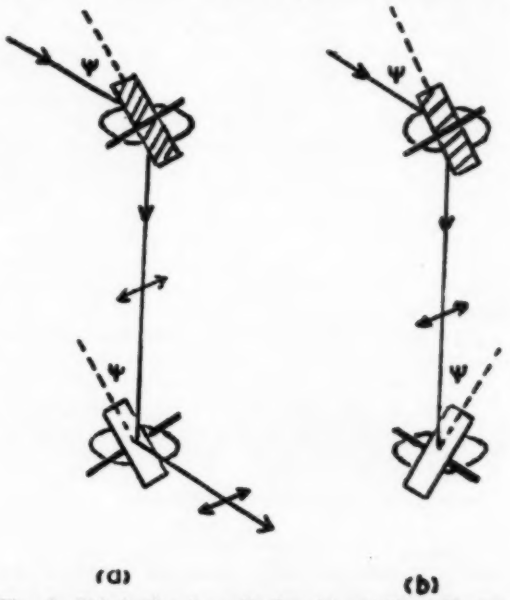


Fig. 3. Polarization by reflection (*a*) parallel reflectors, (*b*) crossed reflectors. Back of mirrors shown shaded, φ is $\pi/2 - $the polarizing angle.

the range 3500-2400A, canada balsam cement must be replaced by glycerol. Calcite polarizers cannot be used below 2400A. For shorter wave-lengths, reflection polarizers are suitable. When unpolarized radiation is incident on a mirror so that the tangent of the angle of incidence is equal to the refractive index of the mirror, the reflected radiation is completely plane polarized. The main disadvantage of such a polarizer is the low intensity it yields. As the light emerging from a monochromator is partially plane polarized, vibration direction perpendicular to the length of the exit slit, for maximum reflected intensity it is essential that the polarizing mirror be suitably orientated with respect to the monochromator exit slit.

The long wave-length limit of transmission of calcite is 20,000A. Above this wave-length, the reflection polarizer just described is used. The reflector consists of amorphous selenium fused on to a glass plate; this reflects about 20 per cent of the incident radiation between 10,000 and 130,000A.

Below 1800A, absorption by air becomes a problem and so it is necessary to enclose the whole apparatus in a vacuum. For infra-red work, the air should be free of carbon dioxide.

Analysers

When plane polarized light is incident on a Nicol so that its direction of vibration is perpendicular to the optic axis, it is obvious that the path of the light in the crystal will be that previously described for the O ray and hence no light will be transmitted. Rotation of the Nicol through 90° will then give maximum transmission; for intermediate positions, the transmission will have intermediate values.

If light leaving a reflection polarizer is incident on a second reflector also at the polarizing angle, then, when the reflectors are parallel, as shown in Fig. 3a, there is maximum reflected intensity from the second reflector. Rotation of the second reflector through 90° from the parallel position (see Fig. 3b) reduces the intensity of the beam reflected from it progressively to zero. Thus any polarizer may be used as an analyser.

If $\bar{\alpha}$ is the observed rotation of the analyser necessary to restore the field of view to its condition prior to the introduction of the optically active substance, then the rotation due to this substance is either $n\pi - \bar{\alpha}$ if the substance is dextro-rotatory, or $n\pi + \bar{\alpha}$ if the substance is laevo-rotatory; n is any integer. To determine the value of n, the angle $\bar{\alpha}'$ say is measured for half the length. Then, either $n\pi - \bar{\alpha} = 2(n'\pi - \bar{\alpha})$, or $n\pi + \bar{\alpha} = 2(n\pi + \bar{\alpha}')$. In general, integers n and n′ can be found to satisfy only one of these relationships: this is assumed to be the correct one. As a check, the rotation for some other length may be measured.

Polarimeter Tubes

For the visible region.—The tubes are covered at both ends by plane parallel glass discs which are either fused on or held in place by holders. The discs must be perpendicular to the incident beam in order not to reduce the intensity incident on the analyser. It is essential that the discs be free from internal stresses; if they are not, the plane polarized light does not remain so and complete extinction is impossible. To test the discs the Nicols are crossed (i.e. optic axes perpendicular) in the absence of the tube; then, with the tube filled with distilled water, the field is viewed while the tube is rotated: it should remain completely dark. As stress may be caused by screwing up holders too tightly, it is advisable to determine the limit of tightening by counting the number of turns for which darkness persists.

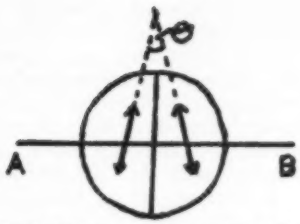


Fig. 4. The half shadow principle: cross section of beams showing vibration directions inclined at angle θ.

Capillary polarimeter tubes have been developed for measurements when the amount of material is too small to fill a standard size polarimeter tube. These tubes require only 1·8-4·6 mg. of substance in about 0·6-1·35 g. of solution.

For measurements of the highest precision, thermostating of the tube is necessary. It is surrounded by a jacket through which water flows at constant temperature.

For ultra-violet and infra-red.—Above 2700A, microscope cover glasses may be used instead of ordinary end-pieces for the tube. Below this wave-length, Cellophane windows are required.

The strong infra-red absorption of water makes polarimetry of aqueous solutions of optically active substances very difficult above 9000A.

The Detector

This may be the eye or a non-visual device. There are three types of non-visual detector: photographic, photoelectric and thermoelectric.

Visual.—When making measurements it is very difficult to judge the position of complete extinction, so that, in practice, a different method, known as the half shade method is used. A half shade device transforms the complete extinction of crossed Nicols into equal illumination of two adjacent fields. To do this, it is arranged that the plane polarized light leaving the polarizer has slightly different planes of vibration in the two halves of the aperture. Suppose these are as indicated in Fig. 4. The angle between the planes is θ which is known as the shadow angle. When the analyser is rotated so that its optic axis is parallel to AB, each vibration has a small component in the transparent direction of the analyser and the two halves of the analyser aperture will appear equally and weakly

illuminated. A rotation of the analyser through $\theta/2$ will obviously increase the intensity of one side of the field and reduce that of the other to zero. Hence the equality of brightness setting is very sensitive. The smaller θ, the greater is the change in illumination for a given analyser rotation, but the fainter is the field. Hence there is an optimum value of θ which will obviously depend on the brightness of the source and on the transparency of the solution. It is therefore advantageous for θ to be variable.

Several types of half-shadow device have been developed. One of the simplest is the biquartz which is a quartz disc whose optic axis is parallel to the direction of incidence. One half of the disc is of laevo and the other of dextro quartz. The disc is 3·75 mm. thick so that the plane of vibration is rotated through 82° for wave-length 5780A, clockwise in one half of the disc and anti-clockwise in the other. The biquartz is placed immediately after the polarizer with the diameter separating the two halves of the disc parallel to the polarizer optic axis. The half-shadow angle is obviously 8°.

The half shadow device used in most modern instruments was devised by Lippich. Two small prisms each occupying a third the aperture of the polarizer are placed after it. The optic axes of the small prisms are parallel and slightly inclined to that of the polarizer, the centre of whose aperture is clear. The observer sights on the edges of the smaller prisms and the analyser is rotated until all three parts of the field are matched. If the eye is off the instrument axis, the illumination of the two side portions of the field is not the same. In instruments with only one small prism (Lippich two prism polarizer), this could escape notice, giving rise to error. The half-shade angle is altered by rotating the polarizer.

Prior to the development of high intensity monochromatic light sources, the polarimetry of liquids and solutions of low transmission presented difficulties. If, in order to obtain more intensity, white light was used then, with an extinction polarimeter, there was no position of complete extinction and, with the half shadow type, there was no position of colour equality over the whole field. It was found that for sugar solutions white light could be used if a quartz wedge were incorporated in the instrument, as sugar and quartz have very similar rotatory dispersion. Such instruments, known as saccharimeters, will not be further described as modern light sources have made them obsolescent.

Photographic.—The range of this type of detector is from 1800-12,000A; different emulsions are, of course, required for different regions. A series of exposures is made on a single plate for systematically varied analyser positions; the developed plate is then studied with a microphotometer. The analyser position corresponding to complete extinction, or, if a half shadow device is used, to equal brightness, can be obtained to an accuracy of $\frac{1}{4}$ min.

The main disadvantage of the photographic method is that it is very time consuming. However, by increasing the exposure time, very low transmission specimens may be studied.

Photoelectric and thermoelectric.—Phototubes have been developed for the visible and ultra-violet; for the infra-red, thermoelectric detectors, or the more modern semi-conducting devices must be used. A comprehensive account of instruments prior to 1946 has been given by Heller (Wiessberger, 1946).

As for colorimetry and spectrophotometry, detectors of this type enable measurements to be speeded up and help prevent fatigue of the operator (see for example Lord, 1958).

Complete Instruments

Two will be described in detail: the ubiquitous high accuracy visual instrument and the latest automatic recording photoelectric instrument.

The visual instrument.—This is shown in section in Fig. 5. Monochromatic light is incident on the slit S; P is the polarizer and N and N′ the two small Lippich prisms. P is attached to the arm Q which moves over the graduated arc R. P may thus be rotated through any desired angle in order to alter the half shadow angle. After leaving the plate glass window M, the light traverses tube LK which contains the solution under examination. The system containing the analyser A can rotate about the axis of the tube, while the framework carrying verniers F and F′ is fixed in position. The

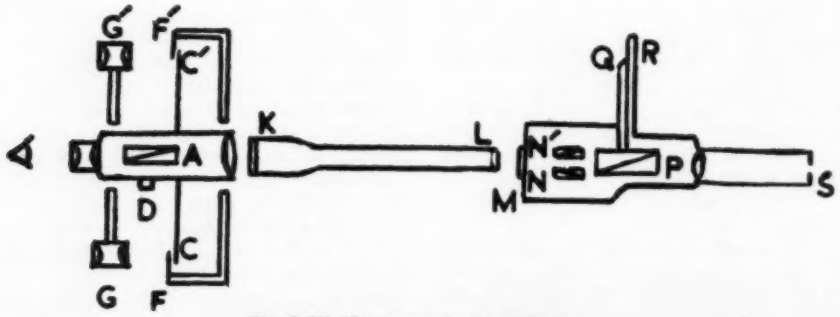


Fig. 5. High accuracy visual polarimeter.

circular scale C C′ moves under F and F′ which are read by the small microscopes G and G′ respectively. Alteration of the half shadow angle causes the zero of the instrument to change; it may be restored by rotating A by means of the adjusting screw at D.

The procedure for adjusting the instrument is as follows: it is first established that C C′ runs smoothly and that the verniers are correctly mounted. C C′ is then tested for eccentricity by taking readings with F and F′ at 0, 45, 90, 135, 180, 225, 270 and 315 degrees. Inequality of the divisions of C C′ is tested for by measuring the length of both F and F′ at different points. Allowance may be made for any errors found. The source is then placed on the instrument axis so that its image falls on the window of the analyser diaphragm. The eye piece is focused on the near edges of N and N′. With LK empty, C C′ is set in the zero position and clamped so as to bring the slow motion into operation, and the exact zero setting made. If the three parts of the field do not have exactly the same intensity, D is adjusted until they do. After inserting the substance under investigation, C C′ is unclamped and rotated until equality is restored; the circle is then again clamped and the final adjustment made by slow motion. The mean of ten readings is taken, equality being approached alternately from either side; finally, the zero is rechecked.

The automatic recording instrument.—The M 500 instrument recently described by Hilger (1959) employs a biquartz which is mounted at the end of a controlled vibrating reed. The plane of polarization thus alternates between two fixed directions. After passing through the specimen and analyser in the usual way, the beam falls on a photomultiplier. Before placing the sample in position, the analyser is aligned so that equal amplitude is obtained from each signal. Rotation of the plane of polarization, caused by introduction of the sample, gives rise to a larger signal from one beam than from the other. The out-of-balance signal so obtained is fed back through a servo control to the analyser which rotates until the beams are balanced again. Results may be indicated in any or all of the following ways:

(*a*) Digital display on a control panel.
(*b*) Digital record on a printer, card punch or tape perforator.
(*c*) Graphic record produced by a standard recorder.
(*d*) Control signal through limit switches.

The instrument may be used for continuous monitoring, for checking at timed intervals and for batch inspection. The range of the instrument is 5·6° for 5461A with an accuracy of 0·02°.

Applications

The main application of polarimetry is in the routine determination of concentration of sugar solutions and of optically active syrups, oils, chemicals, foods and beverages. It is obvious that for these applications there is a tremendous advantage in using an automatic recording instrument.

Dispersion measurements are indispensable in studies of mixtures: mixtures of optically active substances in solution can often be recognized only by their dispersion. It is not always necessary to compile the whole dispersion curve; measurements at two sufficiently different wave-lengths, e.g. mercury lines 4358 and 5461A are often adequate.

Ultra-violet polarimetry is the most important branch of polarimetry for research work, as many optically active organic substances have very high [α] values in the near ultra-violet.

REFERENCES

Heller, W. (1946). Ch. XIX entitled 'Polarimetry' in Weissberger, A. Vol. II, 'Physical Methods of Organic Chemistry'.
Hilger catalogue Ch. 406: (1959). Hilger M 500 Automatic Polarimeter.
Lord, M. P., (1958). Lab. Practice, 7, 154 and 224.

(*To be continued*)

Royal Society Vice-Presidents

The President of the Royal Society, Sir Cyril Hinshelwood, has appointed the following Vice-Presidents for the year ending November 30, 1960:

Sir William Penney, K.B.E., Treasurer of the Royal Society, member for scientific research, United Kingdom Atomic Energy Authority.

Sir Lindor Brown, C.B.E., Biological Secretary of the Royal Society, Jodrell professor of physiology at University College London.

Sir William Hodge, Physical Secretary of the Royal Society, Lowndean professor of astronomy and geometry in the University of Cambridge.

Dr. H. G. Thornton, Foreign Secretary of the Royal Society, lately head of the department of soil microbiology at Rothamsted Experimental Station.

Sir Patrick Linstead, C.B.E., rector of the Imperial College of Science and Technology.

Prof. Wilson Smith, professor of bacteriology at University College Hospital Medical School in the University of London.

Symposium on Carbohydrate Chemistry

A Symposium sponsored by the Chemical Society on the 'Physical, Chemical, and Biological Methods in the Study of High Molecular Weight Carbohydrates' will be held in Edinburgh on July 12-14, 1960. It is expected that those contributing papers to the meeting will include Dr. S. A. Barker (University of Birmingham), Prof. G. Blix (University of Uppsala, Sweden), Prof. E. J. Bourne (Royal Holloway College, University of London), Dr. C. T. Greenwood (University of Edinburgh), Dr. M. Heidelberger (Rutgers University, New Jersey), Prof. E. L. Hirst (University of Edinburgh), Dr. L. Hough (University of Bristol), Prof. J. K. N. Jones (Queen's University, Kingston, Ontario), Dr. B. Lindberg (Swedish Forest Products Research Laboratory, Stockholm), Prof. W. T. J. Morgan (Lister Institute, London), Dr. T. P. Nevell (British Cotton Industry Research Association, Shirley Institute, Manchester), Dr. A. S. Perlin (National Research Council, Saskatoon), Prof. R. D. Preston (University of Leeds), Prof. B. G. Ranby (State University College of Forestry, Syracuse, New York), Prof. M. Stacey (University of Birmingham), Dr. J. R. Turvey (University of Wales, Bangor), Dr. W. J. Whelan (Lister Institute, London). It is hoped that the full programme will be available in April, 1960, and copies will be sent to all Fellows of the Chemical Society, and to others who have applied to the General Secretary, the Chemical Society, Burlington House, London, W.1, before March 31.

MAGNETIC STIRRING OF REACTION SYSTEMS UNDER HIGH VACUUM CONDITIONS

by E. R. Facer and R. D. Batt

University of Otago Medical School, Dunedin, New Zealand

FOR synthesizing 2-methyl (C^{14}) malonic acid from C^{14}-labelled methyl iodide, the apparatus used included a reaction vessel attached to a vacuum train in which the radioactive methyl iodide could be diluted with carrier methyl iodide before adding to the reaction mixture. The reaction mixture usually required vigorous stirring during the addition of the methyl iodide under high vacuum and although, in principle, the use of a glass-enclosed rotor (placed in the fluid) rotated by an externally applied rotating magnetic field, appeared to fulfil the experimental requirements, in practice certain difficulties were encountered. At even a moderate number of revolutions per minute of the magnetic field, the rotor, either revolved out of the centre of the rotating field, or failed to rotate as rapidly as the magnetic field due to friction set up by the reaction mixture. These difficulties were overcome by designing a flask and internal rotor (Fig. 1) which permitted maximum use of the speed of rotation of the magnetic field (1200 r.p.m.) with no danger of the rotor spinning out of the central field.

The glass-enclosed rotor was sealed to a length of glass-tubing which fitted into the B29 socket as shown in the diagram. The bottom of the flask contained a well which had a diameter slightly greater than the length of the rotor. By spinning the rotor in such a well, very efficient stirring of the contents of the reaction vessel was obtained. With viscous reaction mixtures, the vortex which developed with high speeds of revolution of the rotor tended to lift the reaction mixture slightly in the well and reduce the friction on the glass-enclosed magnet.

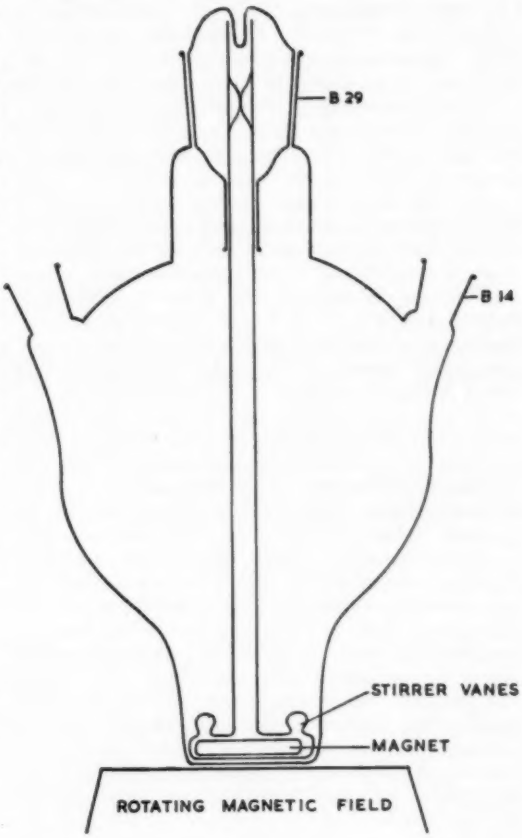


Fig. 1.

APPARATUS FOR ROUTINE ANALYSIS

by G. Lindley

Works Chemical Laboratory,

English Electric Co. Ltd., Bradford

PART IV—CHROMATOGRAPHY COLUMN FEEDER

Introduction

When carrying out separations in columns, e.g. by cellulose chromatography or by ion exchange, it is essential that the top of the bed should always be covered with liquid, and as operations proceed it is necessary to continue to feed this liquid to the column. To facilitate this work, a simple feeder has been made, whereby this operation is carried out automatically.

Description

The construction of the feeder is self-evident from Fig. 1. It has been found that the bore of the delivery tube should be not smaller than $\frac{1}{4}$ in. to ensure efficient

operation. The other proportions can be adjusted if necessary to meet any particular requirements, but the dimensions shown have given good service. A Teflon sleeve should be fitted on the ground joint to prevent it sticking in the socket joint of the flask. To use the feeder, the chromatography column is first prepared in the usual manner, and excess of liquid is allowed to remain in the column funnel head. The required volume of liquid for development or elution, etc., is placed in a B24 ground joint necked flask of suitable capacity, and the feeder then attached. The fore-finger is next placed over the opening of the feeder, the latter is inverted and the opening is submerged into the liquid in the column head. The finger is withdrawn, the feeder with flask is clamped in position or allowed to rest in the column head as shown, and the column is ready for use. As liquid leaves the column the liquid level in the column head falls below the opening of the feeder, air enters the latter and more liquid is displaced into the column thus ensuring a constant feed.

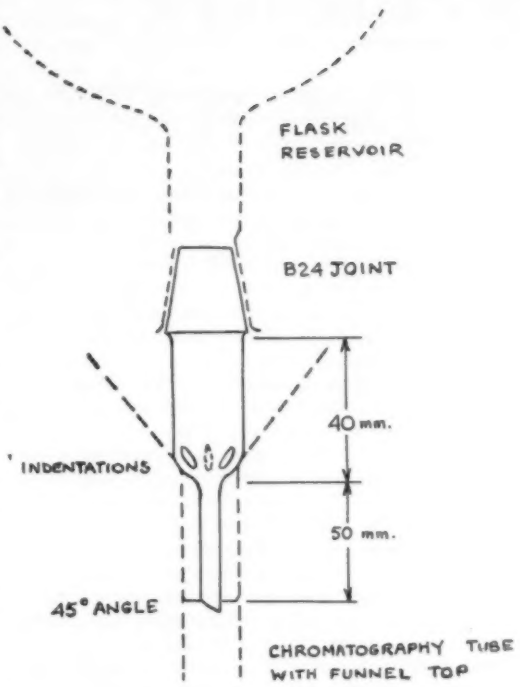


Fig. 1. Chromatography column feeder.

Application

The feeders in use in this laboratory are used for column work with cellulose powder, silica gel and ion exchange resins. They have enabled batches of columns to be run with predetermined volumes of solvents, etc., without any attention, other than when the separations have been completed. Normally clamping is not necessary with flasks containing up to 1 litre of liquid. When used in this manner, the indentations on the feeder allow ample venting of air. When the feeder is in operation the liquid head in the column above the bed does not vary by more than a few millimetres, thus ensuring a constant head feed. No difficulties have been encountered due to vapour pressure within the flasks, even in warm surroundings.

This feeder has also been found useful in the filtering of large volumes of reagent solutions, etc. The solution to be filtered is placed in a flask of suitable volume and the feeder outlet is immersed in the solution in the funnel. In this manner large volumes of solution can be filtered without any attention.

These feeders are now available from Ralph Cuthbert Ltd., Westgate, Huddersfield.

ACKNOWLEDGMENT.—*The author is indebted to the English Electric Co., Ltd., for permission to publish this paper.*

A Pourer for Use with Flasks having Ground Glass Joints

by P. R. Emerson

Boots Pure Drug Co. Ltd., Nottingham

A SIMPLE and robust pourer can easily be made from a standard ground glass cone. Examples are illustrated in Fig. 1.

These facilitate the transfer of liquids from reaction flasks and protect the ground glass joint of the flask particularly when strongly alkaline solutions are in use.

Fig. 1.

BOOK REVIEWS

The Principles of Humane Experimental Technique, by W. M. S. Russell, M.A.(Oxon.), D.Phil.(Oxon.) and R. L. Burch. London: Methuen & Co., Ltd. 1959. pp. 238 + xiv. 30s.

In this book the authors have surveyed humane experimental techniques in relation to the use of animals in laboratories.

The work was sponsored by the Universities Federation for Animal Welfare who are to be congratulated on presenting the scientists' endeavour to reduce the sum total of pain inflicted on animals by man in the quest for further knowledge.

The first chapter outlines the scope of humane techniques as practised in the United Kingdom, who they claim leads in the field of animal welfare.

The second chapter systematically reviews the concept of inhumanity, the problem being, what is and what is not humanity. The inability to measure pain and suffering, and the suggestion that a certain definite amount of pain and fear multiplied by the number of animals exposed to it represents a notional aggregate of suffering, form the basis of the authors' arguments. The subject of specific behaviour pattern is adequately covered by quotations from published work.

The ecology of experimental animals is dealt with in the third chapter. The authors found that insufficient details were given in the Home Office returns and that owing to the definition of an experiment the Home Office figures overestimated the number of animals used annually. Prominence is given to the Laboratory Animals Bureau survey of 1952, carried out by Lane-Petter, Barber and King. The results of this survey are presented afresh but adding little of significance to the original authors' work.

The fourth chapter deals with the sources, incidence and removal of inhumanity; the disturbing and inaccurate suggestion is made that scientists are unmindful of humane considerations. For over 80 years the Home Office have failed to find evidence to support this suggestion.

In chapters five, six and seven the authors deal with the methods of replacement, reduction and refinement by quoting the newer techniques which have been developed (to replace the use of large numbers of animals used) in laboratories. These techniques are used in rather specialized fields. Statistical design and analysis play an important part in reducing numbers. Good animal technicians with their knowledge of animal behaviour make perhaps the most valuable contribution to the humane treatment of animals.

The whole book is difficult to read; it deals very largely in theory and tends to overlook the importance of practical application.

The bibliography is first class, containing valuable references.

Animal experimentation is a controversial subject but the authors are to be congratulated on presenting it in an unbiased, interesting and constructive manner equally suitable for scientist or layman.—G. PORTER.

REFERENCE

Lane-Petter, W., Barber, Pamela A., and King, Hilary J. (1955). Brit. Vet. J., 111, 282-299.

Medical Museum Technology, by J. J. and M. J. Edwards. London: Oxford University Press. 1959. pp. 172 + ix. 21s.

This relatively small volume is a mine of condensed and up-to-date information on the important aspects of medical museum technology. It is written in a concise authoritative style, with the clarity and precision which, no doubt, the authors exercise in their own technological practice.

The first part of the book describes the development of preserving human tissues since the days of the Ancient Egyptians. For the specialist this provides an orderly and fascinating account of the evolution of medical museums, and their contribution to teaching.

The second part describes the discovery of formalin preservation and its revolutionary impact upon museum techniques at the end of the last century, and this short section serves as an excellent introduction to the detailed account of modern techniques which follows, and which occupies the larger part of the book. These are described with illustrations and sufficient detail to be followed by workers who have not hitherto used them, bearing in mind the sagacious *caveat* in the Introduction which advises that 'in medical museum technology, the value and relevance of theoretical writing is limited and theory must not trespass on practice'. The whole of this section provides an up-to-date *vade mecum* for the museum technologist, in which modern theory and practice are usefully summarized. Some techniques, such as those involving the use of solid plastic, still present considerable opportunities for new methods of exploitation. Neither do the authors overlook the applications of display techniques which originated in modern non-medical museums.

To curators the chapter on Organization is probably the most valuable part of the book and would be read with profit by everyone concerned with the planning of medical education. The section on the staffing of a Medical Museum is particularly important. It might have been added that adequate time should be allocated in the medical curriculum for work in such inviting surroundings as the book compels one to visualize.

The volume is indexed and contains a list of suppliers of museum material, which technologists will find most useful. The bibliography contains over 200 references, among which however, it is surprising that the publications of Hackett, concerning Museum layout and technique, do not figure.

In the immediate post-war period the usefulness of medical museums as instruments of education began to be doubted, and even today iconoclasts are not

lacking who would abandon the collections of preserved specimens as the outmoded equipment of former teachers who frequently encountered the late stages of untreated organic disease. The wide circulation which this book thoroughly deserves should do much to dispel this heterodoxy and play an important part in the continued renaissance of the Hunterian tradition.

A. J. DUGGAN.

Steroids, by Louis F. Fieser and Mary Fieser. New York: Reinhold Publishing Corporation. London: Chapman & Hall Ltd. 1959. 144s. pp. 945 + xvii.

How pleasant it is to welcome a really excellent book which sets out to do a useful job and succeeds! This work falls into this fairly rare category. It is not entirely new, in the sense that it is a successor to the third edition (1949) of the authors' well-known 'Natural Products related to Phenanthrene', but there is an enormous quantity of new material and to all intents and purposes this volume is a fresh project to which the authors have brought a wealth of experience and knowledge.

After an introduction on orientation and a semi-historical chapter on cholesterol, the authors divide their work into 10 main sections: 1. The structure of bile acids. 2. Vitamin D. 3. Methods of investigation and structural modification (six chapters). 4. The sterols and their relations to the bile acids. 5. Sex hormones—estrogens, androgens and 'progesterones'. 6. *Homo-* and *nor*-steroids. 7. Adreno cortical hormones. 8. Cardioactive compounds. 9. Sapogenins. 10. Alkaloids. Each of these sections is thoroughly—almost exhaustively—treated, with a clear account of the principles involved, and with a full bibliography. The book teems with structural formulae and schematic charts showing their interrelations and conversions.

The work is commendably up-to-date in that the literature has been surveyed up to February-March 1959. The nomenclature differs somewhat from that recommended by IUPAC in 1957 for steroids, and is thereby occasionally difficult to follow rapidly, but the authors have explained the reason for their divergences and have gathered them, and also the abbreviations used, into a convenient glossary. The use of the word steroid' for 'the group of compounds is, of course, something of an anomaly in itself; it is almost impossible to define a 'steroid' and yet all chemists know what is meant by the term; the authors wisely refrain from attempting a strict definition, but it is astonishing to see the vast number of steroids that have been obtained from plant and animal tissues. It is clear from the account given in this work that the biogenetic route to the cyclopentenophenanthrene system must be infinitely simpler than the laboratory chemical route!

The production of this book is also excellent; the type is easily readable, the formulae clear and the binding strong enough to stand the hard wear that such an outstanding volume will undoubtedly be called on to receive.—G. M. DYSON.

Tools for Biological Research, edited by Hedley J. B. Atkins, D.M., M.Ch.Oxf., F.R.C.S.Eng., Hon.F.A.C.S. Oxford: Blackwell Scientific Publications, 1959. 37s. 6d. pp. 183 + xvi.

This record of a symposium, originally intended for the Surgical Research Society, will undoubtedly interest research workers in many other biological fields. A brief and lucid exposition of each of 10 widely differing procedures with practical applications in biological research gives the narrow specialist an insight into a wider range of modern techniques some or all of which may be capable of making an invaluable contribution to the solution of his own problems.

The ground covered may be judged from the list of subjects treated: statistical design of experiments, flame photometry, electromanometry, tissue culture, tissue transplantation, electron microscopy, phase contrast and interference microscopy for 'weighing' cells, electrophoresis, x-ray image intensification and mass spectrometry. In each case the salient concepts or basic principles are clearly and simply explained with the copious assistance of 113 diagrams and photographs.

Whenever possible, examples of application of the techniques to biological investigations are given.

An important function which this publication will facilitate is teamwork between the biologist and the chemist, statistician or physicist who will often be called upon to make his special contribution to the overall plan of an investigation. For the benefit of the more enterprising and versatile biologist who wishes to carry out some of the procedures himself and is willing to make the effort, sometimes considerable, involved in familiarizing himself with an unaccustomed field, a useful list of references is appended to each chapter. Some of the references however are apparently quoted as authorities rather than for further reading. The works of Sir Ronald Fisher for instance, although readily comprehensible to a trained mathematical statistician will be found extremely hard going for those who have only a sketchy knowledge of mathematics. The text is, incidentally, almost devoid of mathematical formulae.

Printing and format are pleasing. Only seven errors were found namely:

P. 8, line 28 'difference' for 'different'; p. 21, line 13 'has' for 'is'; p. 22, line 29, 'monochrometer' for 'monochromator'; p. 34, line 8 '8' for '7' cycles/sec.; p. 102, line 31, 'n-bulyl' for 'n-butyl'; p. 109, line 15 'mesaxon' should be at the beginning of line 14; p. 138, line 11, 'population' should be plural. The notation '$\dot{V}_A$' on p. 176, line 18, although mathematically correct will probably not be recognized by the biologist as the equivalent to the more familiar $\frac{dV_A}{dt}$.

On the whole the collection of short monographs will be found stimulating and easily readable throughout. It is rather obvious that the method of treatment could be extended to many other modern techniques with similar, gratifying results.—G. F. H. WHITNEY.

STANDARD MATERIALS PROGRAMME EXPANDS

THE National Bureau of Standards is now distributing 60,000 samples of standard materials a year to other laboratories for use in controlling chemical processes and in maintaining the accuracy of apparatus and equipment. A total of over 600 different standard materials are available from the Bureau—principally chemicals, ceramics, metals, ores, and radioactive nuclides.* All are certified either for chemical composition or with respect to a specific physical or chemical property such as melting point, viscosity, or index of refraction. These standards make possible uniform measurements of heat and temperature, define the colours of paints, and calibrate instruments that control the composition of metals and motor fuels.

Within the past five years, requests from American science and industry have resulted in the issue of about 70 new standard materials. Meanwhile, 150 new standard materials are being prepared for issue through programmes of careful analysis and precise measurement. Much of this expansion in the standard samples programme has resulted from current efforts by government and industry to develop materials having specific properties for use at high temperatures or under other extreme conditions.

Fig. 1. Minor isotopic abundances of uranium standards are determined at the National Bureau of Standards by surface-ionization mass spectrometers. The tube pressure is checked during the course of such an analysis.

Chemical Standard Samples

The standard samples programme was established in 1905 when the American Foundrymen's Association turned over to the Bureau four sets of cast iron to be standardized for chemical composition. The majority of these chemical standards are metals and alloys, used extensively for monitoring the thousands of analyses made daily in industrial laboratories. Standards of chemical composition also serve as guides in developing new analytical methods for determining the composition of unknown materials. New chemical standards are prepared whenever an industrial need develops. Recent additions include high-temperature cobalt-nickel alloys for jet and missile production, titanium alloys for aircraft and ordnance research, zirconium alloys for nuclear power development, lithium ores for the new lithium chemical industry, lead-tin bronzes for Navy defence purposes, and portland cement for the cement manufacturers.

About 200 samples of hydrocarbons are issued as 'pure substances' and certified with respect to their degree of purity (99·99 per cent). This category was initiated to fill the gap for standards needed to calibrate instruments, particularly mass spectrometers, employed in controlling the production of synthetic rubber and of special fuels for military aviation. These samples may also find application as gas chromatographic standards. As one of this group, a halogenated hydrocarbon—bromobenzene—is being purified. This compound will be particularly useful in the rubber industry.

In connection with the hydrocarbon programme, a new group of standard samples is being developed. Each of these standards will be a mixture of pure hydrocarbons—rather than one pure compound—and will be used mainly for checking petrol and petroleum fractions. At present, eight, such mixtures are under consideration.

A new set of metal standard samples comprises seven types of steels whose oxygen and nitrogen content have been carefully determined. These reference materials are necessary for the calibration of analytical equipment used to determine the gaseous elements in various kinds of commercial steels. Low gas content is a characteristic of metals with desirable properties, and the acceptable amount of gases present in a metal may be expected to be stipulated in procurement specifications for metals and metals products in the future. With the certification of these standards, the Bureau has begun a programme for producing gases-in-metals standards for a number of metallurgical products. Work is now in progress to develop standard samples certified for the content of oxygen and hydrogen in titanium alloys.

Spectroscopic Standard Samples

High-speed spectrochemical methods of analysis have been extensively adopted in recent years by both producers and consumers of metal products. These methods are essentially comparison techniques in which the spectra from unknown samples are referred to the spectra from samples of known composition. Thus standard samples play a basic role in spectrochemical analysis.

The first spectroscopic samples were developed during the last war in response to a need for standards for high-speed control analysis in steel production and inspection. To date, about 120 of the composition standards have been specifically produced for spectroscopic use. Metals and alloys for 44 new spectroscopic standards have been prepared and are being analysed for content and tested for homogeneity by Bureau scientists, while final plans have been made for 66 others yet to be prepared.

About three years ago, after studying industrial and government needs, the Bureau started a greatly expanded programme on spectroscopic samples. This programme is designed not only to satisfy basic requirements of industry and government for such common materials as cast iron, steel, and copper-base alloys, but also to provide standards of newer materials—such as high-temperature alloys, titanium alloys,

*A complete listing of standard samples is given in Standard Materials NBS Circular 552 (third edition), which may be obtained from the Standard Samples Clerk, National Bureau of Standards, Washington 25, D.C. Supplementary insert sheets to this circular may also be obtained.

Fig. 2. The viscosity of different oils which are used as National Bureau of Standards' standard samples is calculated by measuring the time of flow at various temperatures in a viscometer and multiplying this value by a constant. Here a viscometer is being filled.

and zirconium alloys—the former two finding application in the aircraft and missile industrial fields and the latter in atomic energy installations. The Department of Defence, Atomic Energy Commission, and industrial groups have assisted in selecting the types of alloys needed for these standards and in establishing priorities for their application.

Four corrosion-resistant, high-temperature standards: 19-9DL, AMS 5360A (AISI 316), AMS 5376A (N-155), and Nomonic 80a, and three titanium standards are now available, while a total of 18 other high-temperature standards and six zirconium base-standards will be certified in the near future.

To improve specific physical properties of metallurgical alloys, minute amounts of certain elements are added. Thus the heat-resistant alloys used in rockets and jet engines contain various combinations of boron, tungsten, molybdenum, titanium, zirconium, niobium, tantalum, and aluminium as well as the major metals. Because of the complex composition of these materials and difficulties in chemical analysis, spectrographic and x-ray methods are used to control their quality in production. The Bureau has been preparing standards which are certified for trace elements as well as major constituents. For instance, in a set of eight ingot iron and low-alloy steels recently prepared, 17 elements are included in provisional certificates of analysis, and six more are under study for further certification. Another example is the new set of zirconium standards which is being developed primarily for application in the atomic energy field. Some 30 elements are under investigation in this set, many at the parts per million level.

The field of x-ray fluorescence has become increasingly important for rapid analysis. Like optical emission instrumentation, these newer x-ray instruments require standard samples for their calibration. The Bureau recognized this need several years ago and many spectroscopic standards which are now available or in preparation are designed for x-ray fluorescence analysis. To date 14 standard samples have been developed specifically for x-ray fluorescence while 12 standards are equally suitable for both methods of analysis.

Radioactive Standard Samples

Since 1913, when the United States received its first national radium standard (Radium-6), much of the radium produced or sold in this country has been calibrated against this standard by the Bureau. With the production of radioactive materials in the 1930's, the need for radioactivity standards of elements other than radium has steadily increased, and has been accelerated by the discovery of controlled nuclear fission. For radiation safety, for planning experiments, and for ordering and disposing of active material, a knowledge of the disintegration rate of the specimen is essential. Hence, the total efficiencies of the various radiation detectors under differing experimental conditions must be accurately determined by calibration against radioactive samples.

Today the Bureau distributes standard samples of 40 different types of radioactive nuclides. These standards are used for the calibration of equipment which in turn are used in the measurement of the same types of nuclides. These nuclides have widely varying applications. Several are used medically in the treatment of such ailments as leukemia (phosphorus-32) and cancer (gold-98 and others), as well as in the study of blood formation (iodine-131) and metabolism (carbon-14). Cobalt-60 is used in munition plants to check flaws in casting parts or shell casing. Other nuclides are used to determine such factors as contamination of food crops by strontium-90 and the age of wine and liquors as indicated by the amount of titrated water (water containing hydrogen-3) present.

Fig. 3. Highly purified benzoic acid crystallized in thermometric cells provides a precise standard for calibration of resistance thermometers. The illustration shows a hot super-saturated solution just removed from the oven prior to cooling.

Standard samples of mercury-203, niobium-95, and strontium-85 have just been made available for distribution, while 10 point-source standards—including sodium-22 and zinc-65—are being prepared.

Uranium Standards

The considerable expansion in the application of uranium and related atomic energy materials in recent years has emphasized the need of uniform standards which will be widely accepted for standardizing materials and calibrating instruments. Although various AEC laboratories and contractors have developed standard materials for their own use, a central set of standards was needed.

To meet this demand, the Bureau issues a series of 15 isotopic standards in co-operation with the Atomic Energy Commission. This set, used by educational and research institutions and industries both in the United States and abroad, contains a graduated series of standard samples ranging from uranium depleted in U^{235} (containing 0·5 per cent U^{235}) to a highly enriched material containing 93 per cent U^{235}. Selection of the composition of the intermediate samples was made upon consultation with an advisory committee set up by the AEC. These standards of uranium enable laboratories to evaluate their own reference materials.

In addition to the isotopic range, a natural uranium standard is included in the series. This standard is often used directly as a working standard or control material in experiments. The programme is being expanded to include standards for other atomic energy materials such as plutonium and thorium.

Animals for Cancer Research

The Laboratory Animals Centre are organizing a Symposium on the Provision of Animals for Cancer Research to be held at The Royal Society of Medicine, Wimpole Street, London, on Monday, May 23, 1960.

The provisional programme is as follows:

CHAIRMAN:—Prof. J. S. Mitchell, Regius Professor of Physics, University of Cambridge.

Contributions are expected from the following:

Dr. J. G. Bennette, Courtauld Institute, Middlesex Hospital, London.	Comments on the Inefficiences Inherent in Traditional Methods of Small Scale Mouse Husbandry for Cancer Research.
Prof. F. Bergel, F.R.S. Children's Cancer Research Foundation Inc., Boston, U.S.A.	The Supply of Avian Material: Factors to be Considered in Selecting Supplies.
Dr. J. G. Carr, British Empire Cancer Campaign, Animal Supply & Research Unit, Edinburgh.	
Dr. June East, Division of Physiology & Endocrinology, Imperial Cancer Research Fund, Mill Hill.	Animal Supply and Demand in Practice and Anticipation.
Prof. Alex. Haddow, F.R.S. Chester Beatty Research Institute, Institute of Cancer Research, London.	Fundamental Programmes in Causation, Prevention and Therapy.
Dr. George E. Jay, Jr., Cancer Chemotherapy National Service Center, Bethesda, U.S.A.	
Dr. P. Loustalot, CIBA, Ltd., Switzerland.	Laboratory Animals with Metastasizing Tumours.
Dr. P. R. Peacock, Cancer Research Department, Royal Beatson Memorial Hospital, Glasgow.	Spontaneous Tumours in Mice.
Dr. M. H. Salaman, Cancer Research Department, The London Hospital, Whitechapel.	
Dr. F. Kingsley Sanders, Virus Research Group, M.R.C. Laboratories, Carshalton.	Pitfalls in the Production of Cancer Cells for Experimental Purposes.
Mr. J. D. Whittaker, M.B.E. Medical Research Council, London.	Financial and Administrative Considerations.
Dr. D. L. Woodhouse, Cancer Research Laboratories, Department of Pathology, The Medical School, University of Birmingham.	Present Trends and Future Applications in the use of Animals for Research in Carcinogenesis and Tumour Chemotherapy.

Water Treatment and Examination

The Society for Water Treatment and Examination will be holding its Annual General Meeting in the Library of the Royal Society of Health on Friday, March 11. The business meeting (for members and their guests) will be held at 9.30-10.15 a.m., after which there will be a Symposium on the 'Pollution of Surface Water Supplies' which will be given by:

1. Dr. B. A. Southgate, C.B.E., D.Sc., F.R.I.C. (Director of Water Pollution Research) D.S.I.R.
2. Mr. F. T. K. Pentelow, M.A., (Chief Officer Salmon and Fresh Water Fisheries) Ministry of Agriculture, Fisheries and Food.
3. Dr. E. Windle Taylor, M.A., M.D., D.P.H. (Director of Water Examination, Metropolitan Water Board.)
4. Dr. A. Key, Ph.D., D.Sc. (Senior Chemical Inspector, Ministry of Housing and Local Government.)

The meeting will continue after lunch (12.30-2.15) when the papers will be open for discussion.

The papers, together with the discussion and the reply by the authors will appear in full in the Proceedings, Society for Water Treatment and Examination, Vol. 9, Part 1 (price 10s. 6d.).

By the kind invitation of Arthur Guinness, Son & Co., (Park Royal) Ltd., members will be visiting on the afternoon of Thursday, March 10, their laboratories, brewing processes and the work they do in connection with the control of their trade effluent.

Non-members who wish to attend the presentation of the papers and discussion should communicate with the Hon. Secretary, A. W. H. McCanlis, M.A., F.R.I.C., 41 Carshalton Road, Sutton, Surrey.

Society for Applied Bacteriology

The Winter meeting of the Society was held on Wednesday, January 13, 1960, in the Barnes Lecture Theatre of The Royal Society of Medicine, 1 Wimpole Street, London, W.1. As in previous years a paper reading session was held in the morning from 10.15 a.m.

The afternoon session commenced at 2.15 p.m. and was held jointly with the Microbiology Group of the Society for Chemical Industry when 'Methods for the Evaluation of the Antibacterial Activity of Surface Active Compounds' was discussed.

ALFRED BIRD'S NEW RESEARCH LABORATORIES

The beverage and savoury laboratory. In the foreground is a pH meter, used for measuring acidity in food substances.

ALFRED BIRD'S new research laboratories in Warwick Street, Birmingham—built in nine months at a cost of £120,000—were opened on November 10 by the Viscountess Lewisham, in the presence of the Deputy Mayor of Birmingham, Alderman D. Johnstone, and 100 guests.

The building houses two product development laboratories, an analytical laboratory, instrument room, dark room, fume and balance rooms, research kitchen, process development area containing pilot plant, library and general offices.

A team of 30 chemists, chemical engineers and supporting staff are engaged in research on all types of food products—beverages, savouries and desserts—other than frozen and canned foods. The object of this research is to create new and better food products and the target is to develop two new products to the test marketing stage every year. To achieve this at least 15 new product ideas will be under development at any one time.

The laboratory staff therefore study flavours and flavour

The product development block, containing two main laboratories, an analytical laboratory, instrument room, dark room, fume and balance room, research kitchen, library and general offices.

preferences; create and test new products; develop and improve existing products; evaluate raw materials, develop and improve new manufacturing processes and work on better packaging methods.

Research on new and existing products is carried out in the two main laboratories, one responsible for beverages and savouries and the other for desserts. At every stage of research the products under consideration are checked and tested in the research kitchen to ensure their possible suitability from the consumer's point of view.

When a product has been produced on a small scale in the laboratories it is presented to the marketing division, who assess its possibilities. If these are good, the product is then passed to the process development area and in the pilot plant where engineers and food technologists translate the laboratory findings into manufacturing processes and estimate production costs.

While this is being done, packaging experts are developing and designing new packages to ensure adequate protection and attractive presentation.

When the product is finally ready for large scale manufacturing and selling it leaves the research laboratory for commercial manufacture and packaging in the factory. The new product is sold in a limited test market area to check consumer reactions. Only when the product has been checked thoroughly in this way will it be marketed on a nation-wide basis.

CAMBRIDGE INSTRUMENT COMPANY'S NEW RESEARCH LABORATORIES

THE Cambridge Instrument Company Ltd.'s fine new Research Laboratories at Cambridge are the outcome of a research and development policy that began nearly 80 years ago with Horace Darwin's brilliant and original conception of providing precision instruments for research workers in universities.

Starting with a small workshop and a staff of seven in 1881, the company has steadily grown in size and stature with three factories in the U.K., associated companies in the U.S. and Australia, and accredited agents and dealers in over 30 different countries.

The company's success and present high standing in all branches of instrumentation have been due primarily to the quality and loyalty over a long period of the individuals of which it is composed. An important contributory factor has been the very close relations it has fostered with universities and research establishments. Many distinguished scientists and engineers, such as H. L. Callendar, E. H. Griffiths, G. A. Shakespear, C. R. T. Wilson, W. D. Duddell and H. A. Daynes have brought their problems to Cambridge, and their names are now inseparably associated with instruments that were designed, made, and first marketed by the company. This tradition is still followed and evidence of this today is to be found in instruments such as the Huxley microtome, the dye-dilution curve recording apparatus, and the electron-probe scanning x-ray microanalyser.

The new laboratories, which consist primarily of a three-storeyed entrance block and four-storeyed laboratory block sited adjacent to the Cambridge factory, are an excellent example of co-operation between the scientist on the one hand and the architect and builder on the other. Construction commenced in September 1958 and the building contract was completed in just under a year.

The company's research and development programme is based firstly upon the need for fundamental research into new and more elegant methods of measurement; secondly, upon the need to exploit fully the application of existing methods in science, industry, and medicine; and thirdly, upon the need to improve and develop existing designs.

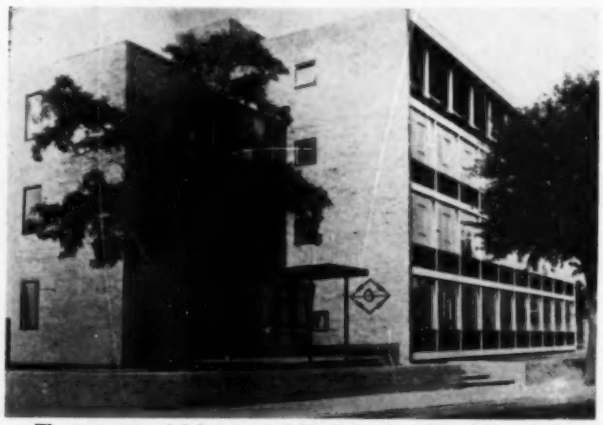
By providing this new building, with its ideal working conditions and first-class equipment, the company has already done much to further these projects, but in the end it knows it must again look to the valuable human material upon which it has placed so much reliance in the past before it can count upon that 'flash of inspiration which marks a new advance'.

Among the items of equipment manufactured by the Cambridge Instrument Company are:

1. *Huxley-Type Microtome.*—The latest Cambridge Huxley-type ultra microtome was designed by Mr. A. F. Huxley, M.A., of the Department of Physiology in the University of Cambridge. Its object is to cut sections with exceptional uniformity for use with the electron microscope. It is designed to produce these sections without the operator having to achieve great skill in its operation.

The advance mechanism has been designed to give sections of known thickness in steps of 50 Ångströms from 100 Ångströms to 1,500 Ångströms.

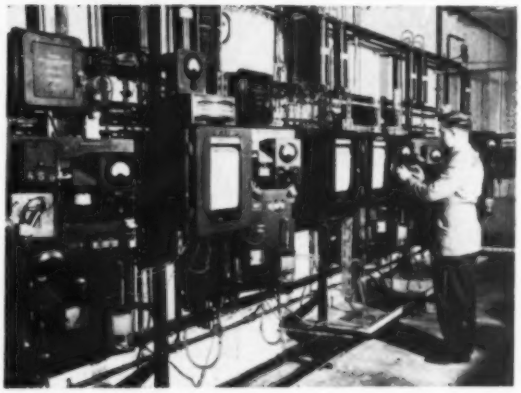
In order to obtain and maintain the desired accuracy, the apparatus is of an extremely solid design. It makes use of strip hinges at all important points, thereby eliminating errors due to backlash and play in pivots. The mechanism is normally covered by a Perspex shield to protect it from draughts, and radiation from the user's body.



The new research laboratory of Cambridge Instrument Co., Ltd.

The new chemistry laboratory.

Electro-chemical dissolved oxygen analyser on test.



2. *Taut Suspension Movements.*—The majority of faults which occur in moving coil instruments in industrial use are due to pivot wear and flattening, and damaged or dirty jewels. Even in laboratory use, under clean conditions, pivot friction is a limiting factor in the use of this type of movement.

By replacing pivots and their associated jewels with short metal bands under tension, the sources of all of these troubles are at once removed. Since the suspensions act also as control force and electrical connection to the moving coil, a very simple, robust and friction-free movement results.

Provision is made in the mechanical design to prevent the suspension strips being stressed beyond a small fraction of their elastic limits in any direction. They are thus resistant to shock of very high magnitude. Under severe vibration conditions, where pivots and jewels would have to be replaced periodically, the taut suspension movement has a very long life.

3. *Cambridge Scanning Electron-Probe X-ray Microanalyser.*—The microanalyser provides a powerful method of qualitative and quantitative metallurgical analysis. Its technique is that of irradiating a minute area of the surface of a metallic sample with a fine-focus beam of electrons, and analysing the resulting emission of x-rays excited in the sample.

This type of analysis differs from most others because of its non-destructiveness and its ability to detect accurately minute local differences in composition. It is, therefore, an extremely useful research technique for examining the detailed structure of metals and alloys.

An important feature of the Cambridge microanalyser is the incorporation of a deflection system in the electron microscope so that the electron beam can scan the surface of the sample. The instrument is not, therefore, restricted to point by point micro-analyses. It can also produce x-ray images showing, in turn, the distribution of selected elements over the area scanned. The x-ray image is displayed on one of two cathode ray tubes. The other tube simultaneously displays a reflection electron image of the same area so that a direct visual comparison between the surface topography of the specimen and the distribution of a selected element can be made easily.

The scanning x-ray microanalyser has already proved itself an exceptionally useful research tool for examining inclusions; the segregation of the constituent elements of an alloy; the effects of electrodepositing one metal on another, etc. Although it has so far been used almost exclusively for studying metallurgical and mineralogical problems, it seems likely that, as soon as its potentialities are more fully explored, it will prove equally useful to the chemist and the biologist. It will, in fact, be valuable in problems where the precise examination of microstructure is important.

4. *Carbon Monoxide Determination.*—A new device for determining carbon monoxide is under development. Its technique is an extension of the well-established methods, in which a catalyst is used to promote the oxidation of carbon monoxide in excess air, the resulting temperature rise during the exothermic reaction being used to estimate the amount of carbon monoxide originally present. The novel test-cell design under development enables high sensitivity and rapid response to be obtained with low rates of gas flow. The apparatus dimensions are much reduced compared with those of some of the earlier equipment produced by the company, of which an example was the Mersey Tunnel monitoring and recording equipment. These were installed in 1934, and are still in continuous use.

The experimental apparatus shown represents the first stages in the development of small, semi-portable equipment for use in road tunnels, underground workings, underground car-parks, and other similar sites where conditions may preclude the use of more bulky apparatus.

Laboratory Note-Book

IT IS now 15 years since the Society for Visiting Scientists came into being, with high hopes and exciting plans. Not all the hopes and the plans have been realized. The S.V.S. was to have been the first of a series of similar societies to be set up in academic centres all over the world—but this one appears still to be unique. Other hopes and plans were dependent on an income of a size that has never been attained. Nevertheless, looking back over those years, financial stringency has not been allowed to cripple the Society's activities.

During the past year, in spite of the increasing demands made on scientists' time and services, three discussion meetings have been held. 'New Light on Vision' was thrown by Prof. R. W. Ditchburn, physicist, Prof. C. H. Graham, psychologist from the U.S.A., and Dr. W. A. Rushton, physiologist, with Prof. W. D. Wright, specialist in technical optics, in the Chair. Less specialized was the following meeting, when the giftie was vouchsafed to 'see ourselves as others see us'. The Society's President was the neutral Chairman; the mirror was held up by Dr. C. Kemal Reheem, Scientific Liaison Officer for Pakistan, Dr. Thomas H. Osgood, Scientific Attaché of the American Embassy in London, and Mr. A. C. Copisarow, Scientific Attaché at the British Embassy in Paris. They were aided in the discussion by a number of United Kingdom Scientific Attachés from abroad, who happened to be meeting that week in London, and by Dominion Scientific Liaison Officers in Britain, as well as by S.V.S. members who had lived and worked in other countries. The most recent discussion meeting dealt with a subject of intimate interest to us all—'Food Processing'. Baked products were the theme of Dr. J. B. M. Coppock, Director of Research of Spillers Ltd.; Prof. H. D. Kay, lately Director of the National Institute for Research in Dairying, spoke on milk and milk products, and food technology and food quality formed the subject of a witty and provocative discourse by Dr. Magnus Pyke, Manager of the Glenochil Research Station of the Distillers Co. Ltd. Dr. E. C. Bate-Smith, of the D.S.I.R. Low Temperature Research Station, presided. The discussion following the papers was animated and keen.

As last year, three receptions have been held. At the first of these members of the International Committee on Laboratory Animals were welcomed. The second reception was rather a sad occasion, for it marked the departure from Britain of Monsieur René Varin and Madame Varin. Monsieur Varin, as Cultural Counsellor to the French Embassy, had for many years been a good friend of the S.V.S. Finally, the Society entertained two Russian crystallographers, Dr. B. K. Vainshtein and Dr. A. N. Lobachev, who came to Britain in December to visit laboratories in this country prior to the setting up of a new crystallographic institute in the U.S.S.R.

The Overseas Science Students Association, who meet at the S.V.S. under the aegis of the British Council and the Society, have continued their usual activities. They have in the past year had lectures from Dr. C. G. Butler, Mr. Antony Hopkins, Prof. Herbert Dingle, Prof. S. Tolansky, Prof. A. V. Hill, Dr. R. L. F. Boyd and Prof. C. A. Barnard. They have organized visits to the G.P.O. Long Distance Telephone Exchange, the Royal Festival Hall and the Houses of Parliament. Informal club evenings have been held for conversation, films and recitals of music of various countries. The advent of the New Year was celebrated by a party; another party was held to bid departing students farewell, and new students were welcomed at a reception at which Dr. and Mrs. D. C. Martin were O.S.S.A.'s hosts—a tradition now long-standing.

The number of periodicals received by the Society as gifts (of which *Laboratory Practice* is one) continues to grow. These are most valuable for the upkeep of their information service, which continues to function for the benefit of scientists abroad and at home.

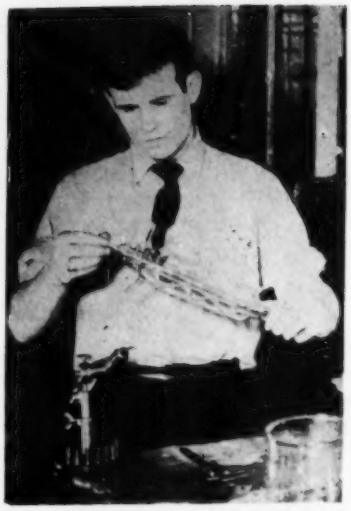
The Society's membership continues to grow. It now has 3,110 members from 67 countries. Old friends return again and again, and new ones express their enthusiasm for the facilities. Membership could be considerably increased if financial resources were sufficient to enable the Society to keep regularly in touch with all members, abroad and at home, and to make its activities more widely known.

A Successful Apprentice

In addition to its annual Exhibition of Scientific Instruments and Apparatus, the Physical Society, each year, organizes a competition for apprentices and learners of either sex to encourage craftsmanship in the scientific industry. Since apprentices of A.E.I. (Rugby) Ltd., formerly the British Thomson-Houston Company, were first entered in 1952, they have gained 17 diplomas in the glass blowing section of the competitions, successes which reflect great credit upon Mr. W. V. Baker, Chief Glass Blower in the Research Laboratory at Rugby, who is responsible for their training.

In this year's competition, a glass blowing apprentice at the Research Laboratory of A.E.I. (Rugby) Ltd. has been awarded two prizes. He is David W. Lanman, of 12 Laburnum Grove, Rugby. In the class for blown silica ware, David entered a single-stage mercury diffusion pump for which he was awarded first prize. In the class for blown glass ware, he gained third prize for a crystallization unit.

In the 1959 competition David won a second prize in the class for blown silica ware and also the class for blown glass ware.



David Lanman fabricating a piece of scientific apparatus in the Research Laboratory of A.E.I. (Rugby) Ltd.

British Scientific Attaché for Moscow

Dr. D. A. Senior, M.A., A.M.I.E.E., has taken up his post as Scientific Attaché to the British Ambassador in Moscow.

He has no specific technical assignment in Moscow but will cover the broad field of science and technology, embracing the physical sciences, biology, medicine and agriculture. His aim is to promote good relations and understanding between the two countries in this field and to facilitate exchanges of information and people. He will advise the Ambassador and will report home on scientific and technical matters.

Since being appointed last April, when he made a brief visit to Moscow, Dr. Senior has been on a fact-finding tour of British industries, universities and technical institutions. He has also continued his study of the Russian language.

News from the British Association of Chemists

B.A.C. Representation in Connection with Further Education

The B.A.C. has been invited by the Governing Body of the Stockport College for Further Education to nominate a representative to sit on the Science Advisory Committee of the College.

Last session the Department enrolled 23 full-time students, 481 part-time day students and 86 evening students; all of these are engaged in the industries which are situated in and around Stockport and the Advisory Committee is being set up in relation to local needs. The subjects of study range through the fields of chemistry, physics, mathematics and the biological sciences and the courses lead to the General Certificate of Education at Advanced Level, Higher National Certificates in Chemistry, Ordinary National Certificates in Applied Physics, University Degrees and the Graduateship of the Royal Institute of Chemistry.

The accommodation of the Science Department is to be considerably extended in the first phase of new building which is at present in progress; a completely new Department has been planned and designed.

After consultation with the B.A.C.'s Manchester Section, Mr. John Wilson, C.B.E., M.C., M.Sc., F.I.R.I., F.R.I.C., was nominated as the Association's representative.

Federation Internationale des Cadres de la Chimie et des Industries Annexes

Readers of this page will no doubt recall that a meeting of the Comité Directeur of F.I.C.C.I.A. in London which had been arranged for October last year had to be cancelled.

We are now happy to be able to announce that in its place a meeting of the Assemblée Générale of F.I.C.C.I.A. is to be held in London on May 7, 8 and 9, 1960. It is expected that there will be three delegates each from West Germany, France and Italy and two delegates each from Switzerland and Belgium. The three delegates of the B.A.C. who are thus in the position of representing Great Britain will, of course, be present.

In addition it is hoped to be able to arrange a meeting to which representatives of other professional bodies in Great Britain will be invited in order that they might have the opportunity of meeting the F.I.C.C.I.A. representatives, a number of whom are also officers or members of the Confédération des Internationale des Cadres—the international general professional association.

The Weekly Appointments Circular

Employers are now invited to insert announcements of vacancies for chemists, chemical and laboratory assistants, etc., in the circular. This is sent every week to all those B.A.C. members who are interested in obtaining appointments, or changing their present posts.

Up till now the B.A.C. has made no charge to employers for this service, but the considerable rise in the cost of production, postage, etc., of the circular has made it necessary for a charge to be made to the advertisers. This will be £2. 2s. 0d. for six lines (approximately 60 words) with a charge of 10s. for each additional line (approximately 10 words).

Some Opinions Expressed Recently by B.A.C. Members

Technical College Facilities

Many of the newer technical colleges seem to be concrete palaces designed to impress the local Mayor and Alderman on State visits. One such building near London seems to contain miles of corridors, with the maximum possible separation of lecture rooms, laboratories and stores that should be located together. One of the principal grouses of the staffs seems to be the complete absence of any small rooms or offices where quiet discussions can be held or where students can be interviewed.

This is understandable enough in the older colleges, but seems quite unpardonable today. It leads to inefficiency in that lecturers and staff cannot do their job properly. I am told it is a policy of the Ministry of Education that all colleges coming under their auspices, as distinct from those directly under University Grants Committees, should not have any special facilities for lecturers. If this is the case, it is high time that this policy was reversed.

Publish it, Please!

A very marked contrast between Great Britain and America is provided by the attitude of chemical concerns to publication. In the United States it is encouraged, and in fact a criticism has been made that there is too much publication of unimportant work. In this country, however, much valuable work is permanently kept in the 'secret' archives of industrial libraries—due to an apparent scare that competitors might discover something valuable. One industrial laboratory of considerable size very rarely publishes any original work, and very few patents. Net result—frustration to the staff, no gain to the country's scientific effort, and usually, publication abroad when the work is performed independently, or years later in a University. It is time that chemists really made their objections felt on the matter of publication.

Throw that Sample Away!

Most chemists engaged on research have a particular *bête noire*—the solemn arrival of a sample from a commercial department with a request to match it 'otherwise we will lose the business and it will be your fault.' How much of the scientific potential of the country is wasted in the good old sport of taking in each other's washing?

With the much larger industrial units of the U.S.A., this problem does not become serious. At the other extreme, with the all State industry of the U.S.S.R., it is bureaucracy rather than petty commercialism which obstructs research. It is true certainly, that the outlook in many European countries is worse than here.

A business exists to make a profit. That does not mean it must follow an entirely retrogressive policy, which in any case is a short-sighted one. There must be a new outlook among business management which will encourage the use of new products, and attempts to find outlets for research products. This will pay much richer dividends, even in the literal sense, then efforts to 'muscle in' on a more progressive competitor, even if it is the easy for 'The Reps'.

All correspondence and enquiries concerning this Association should be addressed to G. R. Langdale, Esq., The British Association of Chemists, Nomination Dept., 14 Harley Street, London, W.1. Tel.: Museum 7021.

Section Programmes

Notts. & Derby

A lecture 'Thermal setting of Tricel' will be given by W. F. Kilby, Esq., B.Sc., A.Inst.P., at the Midland Hotel, Derby, on Wednesday, March 16, 1960, at 7 p.m. (arranged jointly with the Society of Dyers and Colourists).

Liverpool

A visit to Fibreglass Ltd., St. Helens on the evening of Tuesday, March 22, 1960, has been arranged. For further details application should be made to the Hon. Secretary of the Liverpool Section—K. S. Ford, Esq., 30 Fieldway, Maghull, Lancs.

Obituary

The decease of the following members is recorded with regret:

W. T. Butcher. Elected 1918/19. London.

J. F. Ferns. Elected 1939. Bristol & S.W.

J. C. Robertson. Elected 1942. Scotland.

F. N. Mitchell. Elected 1918/19. London.

A. Forshaw, aged 76. Elected 1919. London.

LABORATORY EQUIPMENT & APPLIANCES

Electron Diffractograph

The Trüb Täuber electron diffractograph KD3 has been designed for universal application. Problems in crystallography, physics and metallurgy can be solved using the basic apparatus with standard components. By the fitting of additional parts, the diffractograph is readily adaptable to users' special requirements.

Diffraction patterns can be observed on a luminous screen or recorded on photographic plates or films. A special device which is motor-driven, permits the continuous recording of structural changes as a function of temperature of the object.

The specimen can be etched under vacuum by ionic etching bombardment. A special ion gun of high current intensity with seven beams is designed for this purpose.

It is of great importance in this type of investigation to be able to observe the changes in the diffraction pattern as successive layers of the specimen are etched away. By operating the ion gun simultaneously with the moving film the progressively changing surface structural pattern may be recorded.

Comprising a tube for the electron beam with vacuum equipment and high voltage rectifier, the basic equipment permits recording of diffraction patterns from layers and surfaces, using the so-called transmission and reflection method at room temperatures. Accessories, provided for influencing the object during tests, consist of a specimen holder for heating the object up to 900° C. and a device for cooling the specimen to low temperatures. The diffractograph is so designed that the specimen holders will move the object into any desired position and rotate it about its axis during operation and without interrupting the vacuum. For direct viewing of the specimen an optical microscope is available with a magnification of 200x.

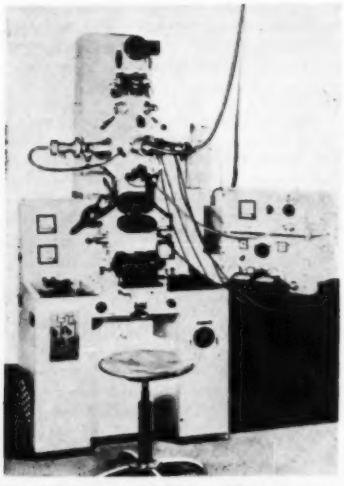
When working with semi-conductors and insulators the effect of loading on the diffraction pattern may be eliminated by the use of slow electrons from a separate discharge device.

Evaporation of metals in the diffraction chamber can be utilized to produce the thin evaporated layers without exposing them to the atmosphere.

The Trüb Täuber cold Induni cathode with an accelerating voltage between 20 and 50 kv., the vacuum equipment with a special oil diffusion pump, and the clear and simple arrangement of the controls make the electron diffractograph very efficient and reliable. The electron optical accessories in the apparatus make it possible to observe micro-diffraction as well as electron optical magnification of the object of about 70x.

Also manufactured by Trüb Täuber —an electron emission microscope for the investigation of metallic and semi-conducting specimens by direct viewing and an NMR-spectrograph for high resolution.

(Sole agents in Great Britain for Trüb Täuber & Co. Ltd.: H. Tinsley & Co. Ltd., Werndee Hall, South Norwood, London, S.E.25.)



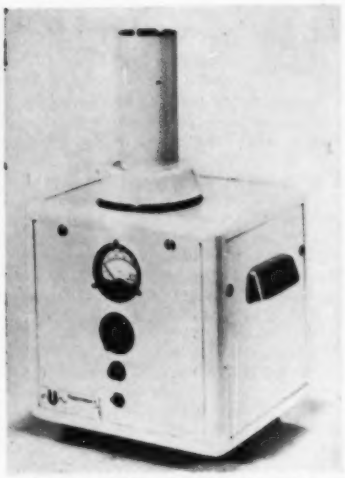
The Trüb Täuber electron diffractograph.

Ultrasonic Cleaning Unit

A low cost, high power, ultrasonic cleaning unit for laboratory use, the Rapiclean 1, is now being marketed.

The following advantages apply:

1. With the Rapiclean one can work even beyond the boiling point of water, because the transducer material is virtually unaffected by temperature.
2. At the chosen frequency of 13 kilocycles, the energy conversion is very efficient.
3. Work done on the Rapiclean can be reproduced in large installations.
4. Only 18/8/3 stainless steel is in contact with the cleaning media.



Rapiclean ultrasonic cleaning unit.

5. The Rapiclean is a complete unit, with its beaker set neatly on top of the cabinet, giving convenient height, and taking up little space on the bench.
6. The simplicity of the design reflects in the price, and brings high power ultrasonics within the scope of every laboratory.
7. The ultrasonics generator of the Rapiclean gives continuously the same ultrasonic output.
8. The transducer is similar to a transformer; it cannot be damaged by periodical overloads, loss of cooling or rough handling.
9. Simplicity of operation is implied by the incorporation of only one switch, one control light, one meter and one tuning knob.

(Marketed by: Ultrasonics Ltd., Westgate, Otley, Yorks.)

Decade Boxes

These low-priced decade units have been designed for the use of engineers, students, laboratory workers, etc.

The production capacitance box has a range from ·001 mfd. to 1·11 mfd., with a zero capacitance of 50 pf. Up to

Dukes & Briggs resistance box.

·11 mfd. the accuracy is ± 1 per cent, and above ·11 mfd. 5 per cent. Maximum voltage is 750 v. d.c.

The resistance box has a range from 100 ohms to 99,900 ohms. The accuracy is ± 1 per cent, and all switch contacts are double. Maximum current: 100's decade 43 mA., 1,000's decade 14 mA., 10,000's decade 4·3 mA. The boxes are grey stove-enamelled, with black and silver panel, and all terminals are captive head screw type with socket, a black one being connected to the case for screening purposes. Dimensions: height 7⅛ in., width 7 in., depth 2⅛ in.

Prices: Capacitance box £10. 10s. 0d.; resistance box £9. 10s. 0d. Delivery is normally seven days.

(Manufacturers: Dukes & Briggs Ltd., Approach Road, Barton Dock Road, Urmston, Manchester.)

Nucleonic Counting Instruments

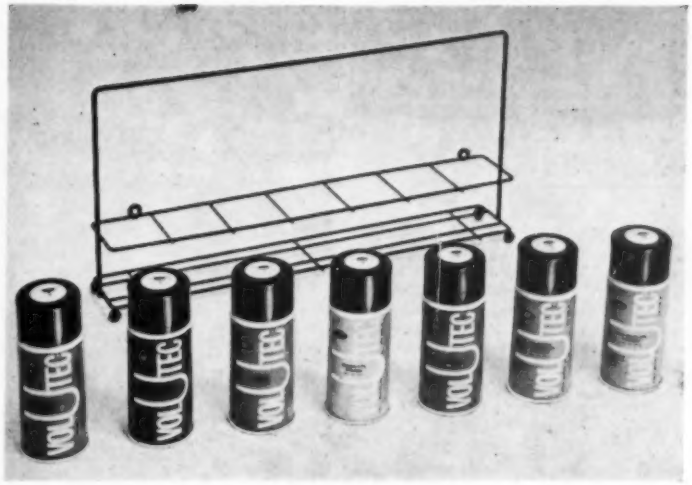
A brand new series of nucleonic counting instruments (the 1800 series) has been designed to give accuracy in operation, full flexibility of application and extreme simplicity of maintenance and servicing. The instruments are supplied in attractively styled cabinets with tilt-up stand so that they can be used singly or stacked one above the other. They can also be converted readily to rack mounting instruments when required. Since all connectors are mounted at the rear and the cabinet is fitted from the front, access can be obtained to the interior without disconnecting cables.

Printed circuit plug-in boards are used extensively throughout the series and an identical power pack is fitted in all units to simplify spares requirements and servicing. Each instrument after 100 hours test is despatched with a fully detailed service manual and packaged spares kits can be provided at the same time.

The first three members of the series now available for delivery are the scaler, type 1800, the high voltage supply type 1820 and the amplifier/selector, type 1830. The price of these instruments in the U.K. is £85 and full specification details are now available from the manufacturers.

(Manufacturers: Isotope Developments Ltd., Beenham Grange, Aldermaston Wharf, near Reading, Berks.)

I.D.L. nucleonic counting instruments.



Volutec aerosol reagents.

Volutec Aerosol Reagents

These aerosol reagents are economical, stable and protected from deleterious effects of light and air. Their use allows the research worker to devote more time to his research and less to the routine preparation of necessary reagents. Furthermore, their self-propellant produces a fine uniform spray and eliminates the need for a compressed air line and expensive, fragile and frequently inefficient spray bottles.

These reagents are of American manufacture but are now available in this country.

(Available from: Schuco International London Ltd., 46 Ravensdale Avenue, London, N.12.)

CATALOGUES, BROCHURES & LEAFLETS

Received from Manufacturers

M. & B. Laboratory Bulletin.—The November 1959 issue of this Bulletin (Vol. III, No. 6) published by May & Baker Ltd., of Dagenham, Essex, includes articles on frontiers of science, laboratory apparatus, University Schools of Chemistry, laboratory chemicals, and chemicals and food.

Pye Application Sheets.—The Applications Department of W. G. Pye & Co., Ltd., of Granta Works, Cambridge, is compiling a comprehensive reference library for the benefit of customers and part of the service they wish to give includes the issue from time to time of application sheets relating to the many and varied uses of Pye instruments. Applications Sheets on pH (pH/1 to 10 and TI/1) have recently been compiled and are supplied free of charge upon request.

Laboratory News.—No. 3 (Third Series) of *Laboratory News* published by J. W. Towers & Co., Ltd., of Victoria House, Widnes, Lancs., contains a special note on Labacta blood agar base, together with details of a wide range of laboratory equipment. The company also announce that owing to increased sales of their model 5 sliding weight balance, they have been able to reduce the price to £9. 17s. 6d.

Volumetric and Lampblown Scientific Glassware.—Catalogue Reference 0659, published by Morbank Ltd., of Victoria Works, Maes-y-Coed, Pontypridd, Glam., gives details of the main standard lines of lampblown glassware (manufactured in both soda and borosilicate glass) made by the company, together with their range of volumetric glassware. This company, established in 1949, is organized as a manufacturing centre for the laboratory furnishing distributive trade and products are not supplied direct to actual users, but only through the normal distributive channels. The prices shown in their catalogue, therefore, are nett manufacturers wholesale figures.

Vacuum Coating.—A new 28 page catalogue has been published by Edwards High Vacuum Ltd., of Manor Royal, Crawley, Sussex, devoted to the subject of vacuum coating. Briefly, the book describes the 12E series with the new 12E7 for multi-layer work and the 12E6 shadow casting unit, optical plant which is the 18E4 and 19VE5 and the various functions of the 24E for mirror coating, selenium plating and cadmium plating.

NEWS

Publications

Trace Techniques

Mr. J. Hetman, F.R.I.C., Chief Chemist of Southern Instruments Ltd., has produced a most useful contribution to polarography (Southern Instruments Ltd., price 25s.).

His book (Vol. I) contains 30 original polarographic determinations using the K1,000 cathode ray polarograph manufactured by Southern Instruments, many of which have not previously been carried out by this technique.

Forthcoming Conferences

List No. 26 'Forthcoming International Scientific and Technical Conferences' published by D.S.I.R. has now been published and amends and amplifies the information contained in the List No. 25 which is superseded.

Directory for Qualified Men

Among industrial companies recruiting qualified men and women, the demand is highest for mechanical engineers. This is shown by the 1960 edition of the *Directory of Opportunities for Qualified Men* (Cornmarket Press Ltd., price 8s. 6d.). Out of nearly 100 companies who give their recruitment requirements in the reference section of the directory, 52 need mechanical engineers. The categories next in demand are chemists, for whom 44 companies have vacancies, electrical engineers—needed by 40 organizations—and accountants, for whom 39 companies have vacancies.

The preface to this year's edition, written by Sir Halford Reddish (chairman and managing director of the Rugby Portland Cement Co. Ltd.), opens an editorial section giving a broad picture of the employment situation. There are articles giving forecasts of the situation in different industries at home and abroad, and a series of graphs based on the Index of Executive Employment which shows clearly how the demand for executives has increased during the past year.

The directory also contains an extensive list of *courses* designed to give qualified men and women and executives a wider view of their own work or to keep them abreast of events in allied industries.

The reference section sets out in detail information about commercial and industrial organizations and government departments. The classified index summarizes in tabular form further information about the size of the organizations, whether men or women are employed, and the areas in which employment is offered. Another index refers men and women with particular qualifications to the organizations recruiting them.

Personal Notes

Lt. Comdr. J. A. L. Stokes.

Lt. Comdr. J. A. L. Stokes

Lt.-Comdr. J. A. L. Stokes has been appointed Group Sales Manager (Home) of Elga Products Ltd. He has been manager of the company's Ion Exchange Division since its inception early in 1956.

Mr. C. R. Evans.

Mr. C. R. Evans

Mr. C. R. Evans has joined Servomex Controls Ltd. as Manager of the Chemical Instruments Division.

Mr. Evans was with the I.C.I. General Chemicals Division as Works Instrument Manager from 1949 to 1956, when he joined the I.C.I. Central Instruments Laboratory. An honours graduate in physics, his work with I.C.I. covered chemical plant instrumentation, automatic control, analogue computers and evaluation of proprietary chemical plant instruments. In 1950 he was elected as Associate of the Institute of Physics.

He is at present supervising several new development projects in the field of chemical instrumentation, as well as the magnetic oxygen analyser being made by Servomex under licence from the Distillers Company Ltd.

Manufacturers News'

U.S.S.R. Orders British Chemical Analysis Equipment

The Russian Trade Delegation has placed an order worth £16,000 for 13 gas-liquid chromatographic analysis apparatus with Griffin & George, Ltd.

The order is the result of demonstrations given to the delegation's scientific representatives at the laboratory at Alperton, and at the Symposium of Microchemistry in Birmingham in 1959.

This is the second order from the U.S.S.R. during the last 12 months, the first being for six instruments. These will be largely used in Universities.

African Tour

Mr. J. E. C. Bailey, C.B.E., M.I.Ex., Chairman and Managing Director of Baird & Tatlock (London) Ltd. and Hopkin & Williams Ltd., is visiting the companies' branches, agents, representatives and customers throughout East, Central and South Africa. The tour will include visits to Nairobi, Ndola, Salisbury, Bulawayo, Johannesburg and Durban, and will help to promote the export of scientific instruments and laboratory apparatus and reagents to these areas.

Quickfit & Quartz Prize

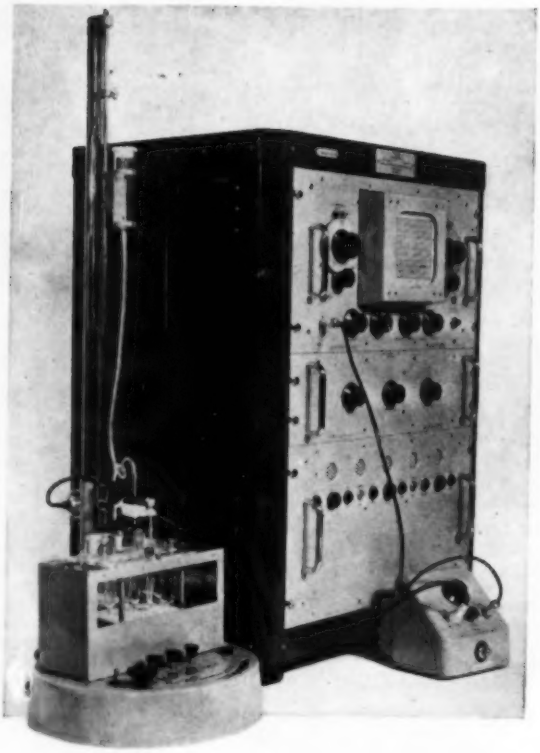
An annual prize—to be known as the Quickfit Prize—will be awarded each year by Quickfit & Quartz Ltd., to the best student taking commercial and professional courses at the County Technical College, Stafford.

The prize will be certificate for the purchase of technical books or instruments.

Change of Address

Beecroft & Partners (Metallurgists) Ltd., have now moved to larger premises at Retort Works, Suffolk House, Sheffield, 2 (*Tel.:* Sheffield 29686) which will enable them to continue the expansion of their 'off the shelf' service for laboratory chemicals, glassware and apparatus and instruments.

Because of the growing demand for the company's range of PVC plastic bungs, production and stocks are being increased.



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Send now for 'Trace Techniques' containing 30 new polarographic methods. Price 25/- post paid. (U.K. only).

Fig. 1. Taken on the stand of Baird & Tatlock Ltd., is the newly introduced B.T.L. Analmatic proportioning pipette. They claim it to be the first instrument of its type ever to be shown. This instrument can be employed for a variety of dispensing, blending, diluting and other liquid transfer operations over a wide range of proportions, and speed and accuracy can be obtained by semi-skilled operators. Mr. P. R. Busby is demonstrating its method of operation.

Fig. 2. Herr Edward Beer of Sartorius-Werke A.G. is seen with their new electronic microbalance, on the stand of Hudes Merchandising Corporation. It is claimed that individual microweighings and/or continuous automatic registration of minute changes in weight or force can be made more accurately and conveniently than with conventional mechanical balances. Readings can be taken instantly on the indicating instrument, which can be remotely situated.

General

Manchester's Chemical Exhibition

The annual Exhibition of Chemical Laboratory Apparatus and Techniques, organized by the Manchester and District Section of the Royal Institute of Chemistry, was held on January 7 and 8 at the College of Science and Technology, Manchester.

In all there were some 33 exhibitors, representing a good range of equipment.

An idea by the organizers at this year's Exhibition was to gum a star-shape 'New Exhibit' label on those items which were said to be new; this meant that visitors who attend each year and anxious to see new products, were able to save themselves a great deal of time.

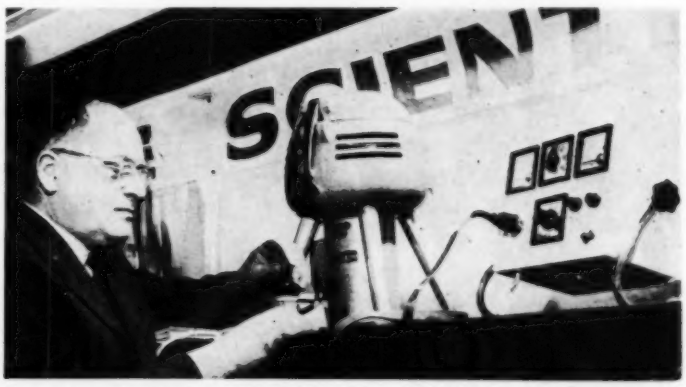

Fig. 3. A new type high speed angle centrifuge was being shown by Orme Scientific Ltd. Operating at 15,000 r.p.m. and a maximum of 20,000 g., the centrifuge is being examined by Dr. R. Neiger, technical consultant.

SIMA to hold British Scientific Instruments Exhibition in Russia

As a result of the report to the Council by the three-man delegation of the Scientific Instrument Manufacturers' Association of Great Britain, which went to Moscow at the beginning of November, and the support from 30 members of SIMA, an exhibition of British scientific instruments will be held in Moscow from June 16 to 26, 1960. This exhibition will be the first to be put on in Russia by a British organization of manufacturers in a specialized field. It is possible that some additional exhibitors will participate and further enquiries are still being received.

Medical Electronics

The International Medical Electronics Exhibition is to be held at Olympia, London, from July 21 to 27, 1960, in conjunction with the Third International Conference on Medical Electronics, organized by the Electronics and Communications Section of The Institution of Electrical Engineers in association with the International Federation for Medical Electronics.

It is a major once-for-all event, embracing all aspects of electronics in medicine, to illustrate the subjects of the Conference and bring together the scientist, medical practitioner and engineer. It fulfils the need for a specialized exhibition on a new branch of science which is fast becoming a new industry. The Exhibition handbook will especially satisfy a need in detailing the international sources of medical electronic equipment and will form a valuable and permanent reference for future years.

laboratory ball mills

Many types available for rolling porcelain or metal containers from 5-gallon to 1-pint nominal capacities.

The mill illustrated is an extremely useful unit for any laboratory dealing with many jobs at the same time on one or more materials of varying quantity or time of processing. Arranged with three pairs of rubber bonded rolls in three tiers each driven by a separate motor allowing all three or one or two to be operated. Each tier takes either two 1-gallon or three ½-gallon or four 2-pint or five 1-pint pots. Combinations of these sizes can be operated simultaneously.

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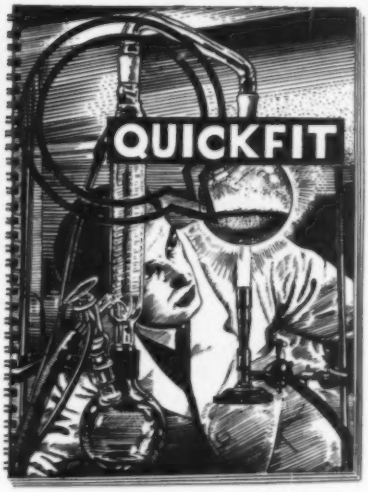

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MEETINGS FOR THE MONTH

Mid-March to Mid-April

We give below a selection of meetings of interest to laboratory workers. Details are as full as possible at the time of going to press, but readers requiring further information or confirmation of arrangements should contact the organizers.

March 7

The Chemical Society (Cardiff Section). In the Chemistry Dept., University College, Cathays Park. 5.30 p.m. 'Developments in the Chemistry of Bacterial Walls', by Prof. J. Baddiley, Ph.D., D.Sc.

March 9

The Society for Analytical Chemistry (Midlands Section). At the University, Birmingham, 3. 6.30 p.m. 'Plant Growth-promoting Substances—Some Analytical Aspects', by Prof. R. L. Wain.

March 8

The Chemical Society (Swansea Section). In the Dept. of Chemistry, University College. 5.15 p.m. 'Developments in the Chemistry of Bacterial Walls', by Prof. J. Baddiley, Ph.D., D.Sc.

March 10

The Chemical Society (London Section). In the large Chemistry Lecture Theatre, Imperial College of Science and Technology, South Kensington, S.W.7. 7.30 p.m. 'Ionic Crystals and their Melts', by Prof. A. R. J. P. Ubbelohde, M.A., D.Sc. F.R.S.

The Chemical Society (Manchester Section). In the Large Lecture Theatre, Chemistry Dept., The University. 4 p.m. 'The Structure of Yeast', by Prof. A. A. Eddy.

The Society of Instrument Technology (Liverpool Section). At the M.A.N.W.E.B. Industrial Development Centre, Paradise Street, Liverpool. 7.15 p.m. 'Instruments of Interest'. Three papers by Section Members.

March 11

The Society for Analytical Chemistry (Western Section). At Swansea. Joint Meeting with the South Wales Section of the R.I.C. on 'Advantages and Disadvantages of Visual Colorimetry', by G. J. Chamberlin.

The Society of Instrument Technology (Midland Section). In the Lecture Theatre of the Byng Kendrick Suite, The Gosta Green College of Technology, Aston Street, Birmingham. 7 p.m. 'Reading with Electronics', by I. Merry, B.Sc., A.M.I.E.E.

The Chemical Society (Irish Republic Section). In the University Chemical Laboratory, Trinity College, Dublin. 7.45 p.m. Lecture by Prof. R. C. Cookson, M.A., Ph.D.

The Chemical Society (Southampton Section). In the Chemistry Dept., The University. 5 p.m. 'Some Problems in Phosphonitrilic Chemistry', by Dr. N. Paddock.

March 12

The Society for Analytical Chemistry (North of England Section). At Manchester. 2.15 p.m. 'The Analysis of Non-Soapy Detergent Products', by G. F. Longman, B.Sc., F.R.I.C.

March 14

The Society of Instrument Technology (Liverpool Section). At the M.A.N.W.E.B. Industrial Development Centre, Paradise Street, Liverpool. 7.15 p.m. 'Automatic Titrators and Related Equipment', by D. A. Patient, B.Sc., A.Inst.P.

The Chemical Society (Swansea Section). At the Chemistry Dept., The University College. 5.15 p.m. 'Optical Rotatory Dispersion in Structural Organic Chemistry', by Dr. W. Klyne, M.A.

March 16

The Society of Instrument Technology (Newcastle Section). In the Conference Room, Roadway House, Oxford Street, Newcastle-upon-Tyne. 7 p.m. 'Instrument Installations'.

The Chemical Society (Aberdeen Section). In the University Union. 8 p.m. 'Complexometric Methods of Analysis: Metals and Non-Metals', by Dr. T. S. West.

The Chemical Society (Newcastle-upon-Tyne). In the Chemistry Dept., King's College. 5.30 p.m. 'Progress in the Study of Heterogeneous Catalysis', by Prof. C. Kemball, M.A., Ph.D., F.R.I.C.

March 17

The Society of Instrument Technology (East Midland Section). At Nottingham & District Technical College, Burton Street, Nottingham. 6.45 p.m. 'Prospecting for Radioactive Minerals', by F. H. Hale, A.M.Brit.I.R.E., Atomic Energy Research Establishment.

The Chemical Society (Bristol Section). In the Dept. of Chemistry, The University. 6.30 p.m. 'X-ray Fluorescence Analysis', by Mr. J. R. Stansfield.

The Chemical Society (Edinburgh Section). In the North British Station Hotel. 7.30 p.m. Three short papers provided by Scottish Agricultural Industries Ltd., Cerebos Ltd., and the Dept. of Chemistry, The University.

March 18

The Royal Institution of Great Britain. At 21 Albemarle Street, London, W.1. 9 p.m. 'Infra-Red Radiation', by R. V. Jones, C.B., C.B.E., M.A., D.Phil.

The Society for Analytical Chemistry (Society Meetings Section). In London. 6.30 p.m. Joint Meeting with the Fine Chemicals Group of the S.C.I. on 'Techniques of Automatic Analysis'.

The Chemical Society (Glasgow Section). In the Chemistry Department, The University. 7.15 p.m. Meeting for the reading of original papers.

March 23

The Society for Analytical Chemistry (Midlands Section). At the Technical College, Nottingham. 7 p.m. Annual General Meeting.

The Society of Instrument Technology (Tees-Side Section). At the Cleveland Scientific & Technical Institute, Corporation Road, Middlesbrough. 7.30 p.m. 'Experience with Flame-failure Devices', by Dr. M. G. Mylroi, M.A., Ph.D. 'The Evaluation of Instruments', by D. M. Bishop, M.A. Annual General Meeting.

March 24

The Society of Instrument Technology (Grangemouth Section). In the 'Ellwyn' Restaurant, Newlands Road, Grangemouth. 7 p.m. Annual General Meeting followed by 'Quiz Panel'.

The Chemical Society (Tees-side Section). At Stockton and Billingham Technical College, Billingham-on-Tees. 8 p.m. 'The Organic Chemistry of Ferrocene', by Prof. P. L. Pauson.

March 25

The Royal Institution of Great Britain. At 21 Albemarle Street, London, W.1. 9 p.m. 'Tyndall, The Teacher', by Ronald King, B.Sc., Ph.D., F.I.M., M.R.I.

The Society for Analytical Chemistry (Scottish Section). At the Royal Society of Edinburgh, 22 George Street, Edinburgh, 2. 7.15 p.m. 'Volumetric Determination of Nitrogen as Nitrate', by A. F. Williams, B.Sc., F.R.I.C., and 'The Control of Quality in Synthetic Foodstuff Colours', by H. E. Stagg, B.Sc.

April 4

The Society of Instrument Technology (South Yorkshire Section). At the University, St. George's Square, Sheffield, 1. 7 p.m. Annual General Meeting, followed by 'Instrumentation at Trostre', by W. R. Owen.

April 5

The Society for Analytical Chemistry (Physical Methods Group). At the Northern Polytechnic, London, N.7. 6 p.m. 'Automatic Analytical Instrumentation.'

April 6

The Society for Analytical Chemistry (Social Meetings Section). At the Meeting Room of the Chemical Society, Burlington House, London, W.1. 7 p.m. Meeting for reading of Original Papers.

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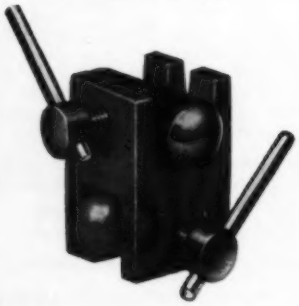

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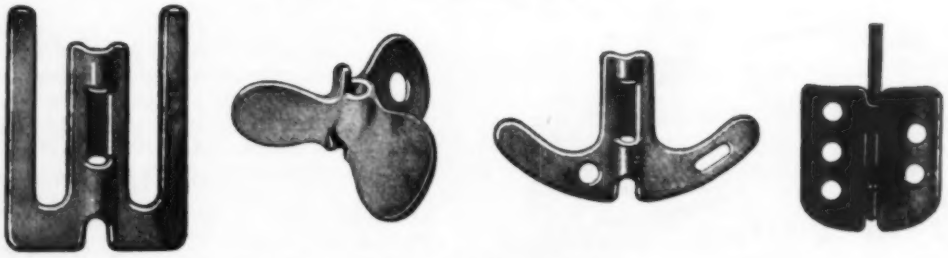

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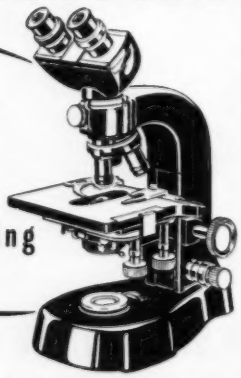

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